The Engineer.

VOL. CLVII.—FROM JANUARY TO JUNE, 1934.

London:

OFFICE FOR PUBLICATION AND ADVERTISEMENTS, 28, ESSEX STREET, STRAND, W.C. 2.

JANUARY 5, 1934.—VOL. CLVII.

THE ENGINEER.

A Seven-Day Journal

New Year Honours.

IN the list of New Year Honours conferred by the King the following names appear:—The Rt. Hon. Evelyn Cecil, a director of the Southern Railway and a member of the Permanent Commission of the International Railway Congress, and Sir William Richard Morris, the chairman of Morris Motors, Ltd., are created Barons, and Mr. Percy John Pybus, late Minister of Transport, a Baronet. Knighthoods are conferred upon Commander E. T. Britten, the master of the "Berengaria"; Mr. Kenneth Lee, Chairman of the Industrial Grants Committee of the Department of Scientific and Industrial Research; Rear-Admiral Sueter, a pioneer in submarine work and aviation; and Mr. Robert Ernest Herdman, the Chairman of Belfast Harbour Commissioners. Lord Weir is made G.C.B. in the Civil Division; while on the Dominions List Mr. Harry Percy Brown, M.I.E.E., of the Postmaster-General's Department, Australia, is made C.M.G. In the Order of the British Empire, Commissioned Engineer William Francis Kearns, of the Royal Australian Navy, becomes M.B.E., and a similar honour is awarded to Mr. William George Phelps, Superintendent Engineer of the Nyasaland Transport Department. In the Indian Order Mr. Lionel Hyde Greg, Chief Engineer of the Public Works Department of Madras, becomes C.I.E.; while Mr. Kenneth Grant Mitchell, M. Inst. C.E., Road Engineer to the Indian Government, receives a similar honour. The Order of the O.B.E. has been conferred upon several engineers in Indian services. Mr. Raymond Patrick Hadow, Chief Engineer of the Irrigation Branch, Punjab, receives a knighthood. In the Royal Victorian Order Sir Richard Glazebrook, K.C.B., now becomes also K.C.V.O. Other honours in the Order of the British Empire include a C.B.E. for Mr. John S. Buchanan, Director of Technical Development in the Air Ministry; an O.B.E. for Captain Mitchell, M. Inst. C.E., Ministry of Transport; and an M.B.E. for Mr. Walter Wellesley Hill, M. Inst. C.E., Resident Engineer, Peterhead Harbour Works, Admiralty, and Mr. George Finch Masters, M.I. Mech. E., of the Royal Ordnance Factories. The driver of the L.M.S. train the "Royal Scot" during the recent American visit is awarded the British Empire Medal.

New Electricity Regulations.

ON December 30th, the Electricity Commissioners issued a revised and consolidated code of regulations made by them for securing public safety and for ensuring a sufficient supply of electrical energy. They come into force from January 15th in respect of all works brought into use and all supplies of energy commenced by the undertakings on and after that date, while, in respect of all other works and all other supplies of energy given by the undertakings, they will apply from January, 1935, in lieu of all prior regulations other than those relating to overhead lines. Within one month after an undertaking has become subject to the regulations, it is to serve a printed copy of them to the local authority if the latter does not happen to own the undertaking. Printed copies of the regulations must be kept at the principal offices of undertakings within the area of supply, and any person will have the right to purchase a copy at the price paid by the undertakings themselves.

Improved Unemployment Figures.

ACCORDING to a statement issued by the Ministry of Labour on Monday evening, January 1st, there were on December 18th, 1933, approximately 10,007,000 insured persons in employment in Great Britain. This total gives 51,000 more in employment than a month before, and 567,000 more than a year before. The total number of registered unemployed persons at December 18th was 2,224,079, a reduction since November 20th of 55,938, and a reduction of 499,208 as compared with the figures for a year ago. There was a further improvement recorded in coal-mining, iron and steel manufacture, engineering, motor vehicle, and metal goods manufacture, the cotton industry, and the distributive trades, as well as road transport and the shipping industries. Alongside this improvement a large increase of unemployment took place in the building trades, which was brought about by the severe weather conditions; smaller increases in unemployment were recorded in the pottery, hosiery, and boot and shoe industries. The reduction in unemployment in the principal industries of interest to our readers are indicated in the figures given below. Coal-mining, 46,361; engineering, 7302; iron and steel manufacture, 4535; metal goods manufacture, 3995; the distributive trades, 17,528; shipping services, 1685; and road transport, 1310. The upward trend of employment figures characterised the monthly returns throughout the whole of last year.

Patents in 1933.

ALTHOUGH the returns of the exact number of patents applied for during 1933 have yet to be made public, it is anticipated that they will show a decrease of some 300 applications as compared with the year 1932, when 37,052 patents were applied for. The reduction in applications has, it is thought, no direct relation with the condition of trade, but is probably attributable to the fewer applications made for patents by clients of foreign nationality. There was a steady increase in the number of applications from the year 1924 up to 1929, when the number of 39,898 was the highest recorded. Since 1929 the number of applications has fluctuated somewhat; it fell in 1930 to 39,539, and the following year there was again a fall of about 3000 applications, which, however, was reduced by about 1000 in 1932. It is pointed out that in contrast to these modern figures there were during the second half of the sixteenth century fifty-five grants of privilege (patents) made by the Crown, of which about twenty were made to aliens and thirty to natives, the remainder being granted for the purpose of regulating trade.

Loss of a British Air Liner.

A SERIOUS British air liner disaster, in which the lives of eight passengers and those of the pilot and the first officer of the machine were lost, took place in Belgium shortly after 1.15 on Saturday, December 30th. The machine, which was totally destroyed by fire, was one of the smaller Imperial Airways liners, the "Apollo," and was on the Cologne, Brussels, and Croydon service. The air liner left the Brussels aerodrome at 12.20, but owing to dense fog was diverted from her normal course and took a more northerly route. Between Ghent and Bruges it collided with the aerial system of the Ruysselede wireless station and a landing wheel and one wing of the machine were broken off. Fire took place immediately after the crash, and despite brave efforts made by the officials and workmen of the wireless station, it was not possible to save anyone. One of the eight 900ft. pylons was broken off about 250ft. from the ground, probably owing to the machine fouling some of the guy ropes. An official inquiry will be held in Belgium. It is thought that the machine was either flying low on account of having just run into a new weather front or that the formation of ice on the surface of the wings had caused the machine to lose some altitude.

The Late Mr. C. F. Mackness.

IT is with regret that we record the recent death of Mr. Cyril Francis Mackness, M.I.E.E., Mem. Am. I.E.E., who was the senior partner of Mackness and Shipley, consulting engineers, of Westminster. He was educated at the High School, Dundee, and, although he left there to join the staff of the local branch of the Bank of Scotland, where he remained for several years, he had acquired such a taste for engineering in the school workshops that, in the face of much opposition, he apprenticed himself in 1898 to the Sunderland Forge and Engineering Company, Ltd. Two years later he joined Bruce Peebles and Co., Ltd., in Edinburgh, and became chief of test. During all this time he continued his studies at the Durham College of Science in Newcastle-on-Tyne, and later at the Heriot Watt College in Edinburgh. In 1902 he became assistant to Messrs. Carruthers and Elliot, consulting engineers to the West Australian and New South Wales Governments, and was engaged on important inspection work in Germany and Switzerland. He subsequently joined the A.E.G. of South Africa, Ltd., of London and Johannesburg, and as that firm's assistant manager in 1904, he helped to develop a great world export business. During the next ten years he was entrusted with many important missions, and visited for his firm the United States, Mexico, and the whole of South Africa and Rhodesia. In 1914 he became assistant manager of the electrical department of Vickers, Ltd., and in 1919 he formed and became the chief engineer of the hydro-electric department. Later he was chief of the company's general engineering department. In 1923 he began business as a consulting engineer, and his firm carried out many important works for clients in England, from the Continent, the United States, and Canada.

British Trade Prospects.

IN a New Year message, the Secretary of the Department of Overseas Trade, Lieut.-Colonel John Colville, says that he considers that the outlook for British trade is brighter to-day than it has been for some time. Even the worst years have brought their opportunities, and 1934, which promises to be an improvement upon its immediate predecessors, will find Britain's industries alert to make use of improved conditions. A good indication of the condition of Britain's many industries is, Lieut.-Colonel Colville points out, the British Industries Fair, and it is significant that the next Fair, which opens at Olympia and the White City, London, and Castle Bromwich, Birmingham, on February 19th, will bring together a bigger and more varied range of British products than has ever been assembled before. The Fair will show, he says, that British prices are competitive, and that adaptations and improvements carried out in the lean years have equipped Britain's industries to supply just those goods which market conditions demand. Already there is evidence of interest of overseas buyers in the 1934 Fair, and a record number of Continental countries have agreed to arrange for reduced travel rates to encourage attendance by their trade buyers. There are yet many difficulties to be surmounted in international trade, but Lieut.-Colonel Colville believes that trade revival has begun, and that Great Britain is in a position to lead that revival.

Irrawady Bridge.

ON Tuesday, January 2nd, the Ava Bridge over the river Irrawady at Sagaing, near Mandalay, was formally opened by the Governor of Burmah, Sir Hugh Stephenson. The bridge, which is nearly three-quarters of a mile in length and has ten spans, nine of 360ft. and one of 260ft. in length, replaces the existing ferry between Amarapura and Sagaing. While it has been built primarily for railway purposes, at the request of the local Government, which has contributed some £142,000 towards the total cost of about £1,125,000, cantilever supported roadways, each 12ft. wide, have been built out at either side of the railway track. The building of the bridge was sanctioned in 1927 and an immediate start was made, but the work of sinking the caissons had to be suspended each year during the rains, when the river was in spate, making progress somewhat slow. The designs for the bridge were prepared by, and the work has been carried out under the supervision of, Messrs. Rendel, Palmer and Tritton, of Westminster, the contractors being Braithwaite and Co. (India), Ltd. The materials were supplied from Great Britain, Burmah, and India, and the total weight of steel used in the superstructure is estimated at close upon 11,000 tons.

The Development of the Parsons Steam Turbine.

No. I.

IN all the history of steam engineering no event has more profoundly influenced progress than the invention of the Parsons steam turbine. At the time of its appearance the reciprocating engine was fast approaching the practical limits of its development. Imposing as were the greatest masterpieces of the engine builders, structural considerations confined them to a maximum of a few thousand horse-power and no refinement of design could raise their efficiency beyond a figure low according to modern ideas. The end of their evolution was in sight and steam engineering, therefore, seemed almost to have reached a point beyond which it would be impossible to go. Such, indeed, must have been the case had not a new horizon opened out by the introduction of the turbine principle. By deriving energy from the velocity of expanding steam rather than from its pressure, every limitation imposed by the mechanics of the piston engine at once disappeared. The turbine enabled the power which could be developed with a given weight of machinery in a given space to be multiplied a hundred-fold. It gave the pure rotary motion at high speeds so desirable for the driving of electric generators, and it combined with these advantages a great economy of steam. Its invention has alone rendered possible the widespread distribution of electric energy, which means so much to our industrial and social organisation. On the sea it has attained the same pre-eminence as a source of power as on land. All the navies of the world are turbine-driven, while the largest and fastest vessels of the mercantile marine are propelled by the same means. The aggregate power of all the turbines now in service is incalculable, the units ranging from the tiny machines for driving a lubricating pump or a locomotive head light, to the monsters of a quarter of a million horse-power or more built for central station work. That such a development took place during the life-time of the man who first demonstrated the practicability of the turbine principle as applied to steam, is one of the most remarkable facts in the annals of engineering. The story of the steam turbine is an epic of which the central figure will always be acknowledged to be Sir Charles A. Parsons, to whose genius, energy and foresight we owe, not only the original invention, and its firm establishment in the face of ignorance and prejudice, but improvement after improvement throughout his life. "*Si monumentum quæris, circumspice.*"

The history of the Parsons steam turbine may be said to have commenced on April 23rd, 1884, when two patents were filed by the Honourable Charles Algernon Parsons, who was at that time a junior partner and the chief of the electrical department in the firm of Clarke, Chapman, Parsons and Co., Ltd., of Gateshead-on-Tyne. The patents were allied, the first in the numerical order of the Patent Office being for a method of constructing dynamos suitable for very high speeds of rotation and the second for a steam-motor on the turbine principle, mainly for the driving of such dynamos. It was this latter patent from which the modern turbine sprang. It covered a cylindrical, bladed, rotor within a cylinder, the latter being furnished with inwardly projecting blades, the rows of which alternated with those of the rotor. The steam, flowing parallel to the axis of the machine along the annulus, between the rotor and the cylinder, underwent a slight pressure drop in passing through each successive row of blading, the velocity thus acquired being expended in driving the rotor blading. The underlying idea was to avoid the excessive and unmanageable velocity which the steam would have attained by allowing it to drop to the exhaust pressure in a single expansion. By the graduated lowering of the pressure, stage by stage, along the turbine, both the velocity and the changes in volume were kept throughout within reasonable bounds and design could follow, *mutatis mutandis*, the general lines of a hydraulic turbine. That such considerations were dominant in the inventor's mind is evident from a statement made by him many years afterwards. In the course of his address as President of the Birmingham and Midland Institute in 1922, he said: "In commencing to work on the steam turbine in 1884, it became clear to me that in view of the fact that the laws for the flow of steam through orifices under small differences of head were known to correspond closely with those for the flow of water, and that the efficiency of water-turbines was known to be from 70 to 80 per cent., the safest course to follow was to adopt the water turbine as the basis of design for the steam turbine. In other words, it seemed to me to be reasonable to suppose that if the total drop in pressure in a steam turbine were to be divided up into a large number of small stages, and an elemental turbine like a water turbine were placed at each stage—which, as far as it was concerned, would be working in an incompressible fluid—then each individual turbine of the series ought to give an efficiency similar to that of the water turbine, and that a high efficiency for the whole aggregate turbine would result; further, that only a moderate speed of revolution would be necessary to reach the maximum efficiency." Obvious as the principle of progressive expansion now appears, the invention must be regarded in the light of the state of the art at the time. There was no steam turbine of any kind in existence, and such efforts as had been made to develop power from the velocity of steam had met with little success. It is true that various inventors had propounded plans for the more rational utilisation of steam in machines of the turbine type, but no such machines had assumed a practical form and steam engineers in general believed that any attempt to supersede the reciprocating engine was foredoomed to failure.

Reference to the original patent will also show a remarkable foresight as to the lines on which turbine machinery would be developed. The second claim embodies the principle of double-flow, whereby the steam is caused to travel simultaneously in opposite directions, thus balancing the end-pressures and at the same time enabling the length of the blades to be reduced by half. Without this principle the efficient construction of the immense machines of to-day would not be practicable. The same remark applies equally to the principle of dividing up the whole machine into two or more parts dealing with the steam in series, a feature typical of all the largest modern units, and particularly useful in marine work, where speed reducing gears are used or where more than one propeller shaft has to be driven. The application of the turbine to marine propulsion was even more definitely envisaged by the claim for the use of multiple propellers in series, to avoid the difficulties anticipated with single propellers at very high speeds. The first turbine vessel, the famous "Turbinia," was, indeed, fitted with multiple propellers, but experience showed that a single propeller per shaft was more efficient. The use of a reversed turbine as a pump or compressor was another proposal which has had a practical outcome. Driven, as the inventor suggested, by a direct steam turbine, the combination was the origin of the standard modern turbo-compressor, or blower, so largely used in blast-furnace work. The possibilities of the gas turbine were also in the mind of the inventor, who suggested the use of a turbo-compressor for the inevitable work of compressing the gas, the compressor to be driven by a gas turbine having suitable cooling arrangements for the blades. This is, perhaps, the only adaptation of the turbine principle covered by the patent which has not, as yet, borne practical fruit, though, should success ever be achieved, it will probably follow the lines indicated by Mr. Parsons in 1884.

Notable as was the vision as to the future of turbine machinery, the appreciation of the mechanical problems involved was no less complete. Engines were limited to a few hundred revolutions per minute at the most, but the turbine principle, even when the pressure was reduced by stages as described in the patent, required speeds of many thousands of revolutions per minute if the steam was to be used at all economically. With centrifugal forces amounting to something like 6 tons per pound of rotating blading, the design and attachment of the blades was a problem in itself. But there were also the bearings to be considered, and their method of lubrication. Then, apart from the difficulty of accurately balancing a long high-speed rotor, there was the further problem of securing vibrationless running in spite of the inevitable, though minute, want of homogeneity of the material or lack of absolute perfection in workmanship. Some method, too, had to be devised for governing the machine at such unaccustomed speeds, for anything in the nature of a run-away would have been disastrous. The thought which had been given to all these matters before the pioneer patent was taken out is shown by the means suggested in the patent for dealing with them. The solutions proposed were practical ones, and enabled the turbine principle to be immediately demonstrated by the construction of the first commercially useful machine.

The First Parsons Steam Turbine.

No time was allowed to elapse by Mr. Parsons between the application for his first patents and the construction of a turbine and dynamo in accordance with them. In the same year he built, at the works of Clarke, Chapman, Parsons and Co., the pioneer of all modern steam turbines, the historic machine illustrated in Fig. 1, which, after many years of useful service, has been deservedly given a permanent home in the Science Museum at South Kensington. The unit developed a power of about 7·5 kilowatts at 100 volts and at a speed of 18,000 revolutions per minute. It worked with saturated steam at a pressure of 80 lb. per square inch at the stop valve and exhausted at atmospheric pressure. Under such conditions its steam consumption was about 129 lb. per kWh. A study of its design is instructive, for the details of its construction formed the starting point for the vast evolution which has since taken place. Reference to Fig. 1 shows that the machine was of the double-flow type, the steam entering the casing at mid-distance along the rotor and flowing, half to each end, thus avoiding the end thrust, due to the steam pressure which would have had to be taken care of in a single-flow machine. The two exhausts were brought back to a central outlet by means of ports in the casing. The rotor was constructed by threading a number of gun-metal rings on the shaft, the rings being held tightly together and in contact with the central collar by nuts at the ends. The projecting portions of the rings were cut through with slots at an angle of about 45 deg., the leaves of metal left between adjacent slots serving as blades for the steam to act on. The upper and lower halves of the casing were fitted with half blade rings of a similar nature, alternating with those of the rotor. Towards each end of the turbine the slots became wider and the blades longer, thus providing for the increasing volume of the steam. From the nature of their construction the blades were necessarily flat or nearly so, but their edges were sharpened at the entry and exit sides. Their form was dictated much more by the facilities available for manufacture than by theoretical considerations of efficiency. A photograph of one of the rings of rotor blading is given in Fig. 2. The steam in expanding to atmospheric pressure from a pressure of 60 lb. gauge, passed through fifteen rows of moving blades and an equal number of rows of fixed blades, thus completing its expansion in thirty pressure steps. The velocity acquired by the steam owing to the pressure drop between the entrance to consecutive rows of running blades was of the order of 450ft. per second, requiring a blade velocity of about 350ft. per second for its efficient utilisation. Actually, the blade velocity was 250ft. per second.

The rotor was supported in bearings specially designed in accordance with one of the claims of the original turbine patent to secure vibrationless running.

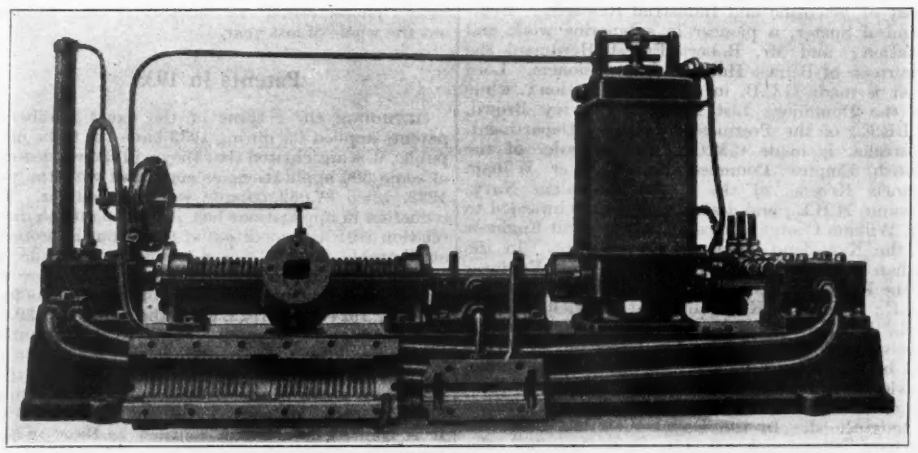


FIG. 1—THE FIRST PARSONS STEAM TURBINE

The shaft ran in a long thin sleeve, which was surrounded by a large number of washers alternately fitting the bush and the casing. The washers were held in contact with each other by the pressure of a short helical spring surrounding the sleeve near its end and tightened up by a nut screwed on the sleeve. The arrangement permitted the shaft both to align itself and to rotate about its centre of gravity, should this not be coincident with its geometrical centre. Thus the conditions for smooth running at speeds above the critical were fulfilled. The bearings were continuously lubricated by oil supplied by a screw pump formed on the end of the turbine shaft. Since the pump was above the normal oil level in the collecting chamber beneath, it had to be primed, and this was effected by the reduction of the air pressure over the oil by the suction of a small fan mounted on the turbine shaft. This fan was of exceedingly simple construction and well adapted for the high speed at which it ran. It consisted essentially of a metal disc drilled with radial holes. These communicated with axial holes in the boss which served as inlets for the air. The suction side of the fan was connected by a small pipe to the top of the vertical standpipe on the collecting chamber. The same fan also played a part in the governing of the turbine speed. The partial vacuum which it created was arranged to cause the deflection of a spring-loaded leather diaphragm, which is to be seen above the end pedestal in Fig. 1. Attached to the centre of the diaphragm was a rod, the movement of which actuated the throttle valve of the turbine. An unduly high speed of rotation increased the vacuum behind the diaphragm, and so closed the throttle.

Superposed on this system of governing was an electrical method of control which provided a fine adjustment of speed in accordance with the voltage at the generator terminals. On the top of the dynamo

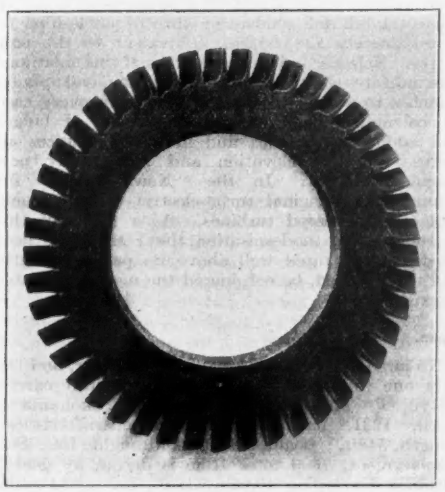


FIG. 2—RING OF ROTOR BLADING

was mounted a soft iron bar pivoted at the centre so as to enable it partially to rotate about a vertical axis. The magnetism of the dynamo field tended to cause the bar to take up a position in line with the field, a tendency which was resisted by an adjustable spring. The motion of the bar under the magnetic influence caused one of its ends to move more or less across the inlet of a pipe connected to the suction side of the fan mentioned above. The fan suction was thus throttled proportionally to the magnetism of the poles of the dynamo, and hence, the machine being shunt wound, to the voltage at the terminals. This throttling of the suction increased the partial vacuum behind the diaphragm and so regulated the governing of the turbine.

Since the turbine was designed to expand the steam down to atmospheric pressure, there was no tendency either for steam to leak outwards or for air to leak inwards at the points where the shaft emerged from the casing. The gland problem was therefore simplified. Nevertheless, some precautions had to be taken to avoid the nuisance of escaping steam should the terminal pressure be slightly in excess of that of the atmosphere. Approximate steam-tightness was assured by a washer on the shaft running in contact with the collar of a bushing. Beyond the bushing a chamber was formed in the casting, from which all steam and water coming through the bushing was drained off, the draining being assisted by the action of a small steam ejector. In this system of preventing external leakage will be recognised the germ of present-day gland design.

THE PARSONS DYNAMO.

The dynamo, patented and constructed at the same time as the turbine, presented its own problems of peculiar difficulty. It was a bi-polar shunt-wound machine, capable of an output of 75 ampères at 100 volts. The common speed for small dynamos of that date—and there were, of course, no large ones—was from 1000 to 1500 revolutions per minute, the speed being obtained by a belt drive from the fly-wheel of a reciprocating engine. It was a bold enterprise to construct a dynamo capable of working at 18,000 revolutions per minute, for nothing of the kind had ever previously been attempted. The problems to be solved were both electrical and mechanical. The alternations of magnetism in the armature core were vastly more rapid than in any machine yet built, and the possibility of overheating due to excessive eddy current losses was not overlooked. From the mechanical point of view, the centrifugal stresses were also far greater than in ordinary practice, every pound weight of metal at the surface of the armature developing a centrifugal force of about 5½ tons.

The armature spindle was of high carbon steel, 1¼in. diameter inside the core and about 27½in. long between the centres of the bearings. The latter were ½in. diameter by 3½in. long. The armature spindle was bored through from end to end to permit of a circulation of oil through it for cooling purposes, but this was found in practice to be unnecessary. The diameter of the armature over the windings, which were of the external drum type, secured by binding wire, was 2⅝in., the diameter of the core being 2½in. The latter was composed of thin iron sheets, built up to form a length of 8in., with notched driving discs of red fibre at each end. The armature had fifty conductors, and the commutators twenty-five segments. The individual commutator bars were not continuous, but each was formed of six separate lengths held together by the end pressure of the tightening nut. The object of this construction was to resist better the centrifugal forces, as each length could be held separately by dovetailed steel rings engaging with its ends. The bars were insulated from each other, and from the shaft and holding rings by sheet asbestos. The building up of the commutator bars from short lengths dovetailed into steel rings, and the use of asbestos as insulation, were features of the original patent, as were also the spiral end windings of the drum armature. The soundness of the instincts of the inventor were borne witness to in a paper read by Messrs. Gerald Stoney and A. H. Law before the Institution of Electrical Engineers in 1908, when the authors stated, with reference to the machine in question: "It is remarkable how closely the magnetic densities, ampère turns per inch diameter of core, and other electrical quantities agree with what we would now adopt if we were called on to make a similar dynamo, and this is all the more remarkable as the theory of the dynamo was very imperfectly understood twenty-four years ago, little being known about magnetic densities and still less about hysteresis and eddy currents."

In the early days of the turbo dynamo, the field magnets were constructed entirely of cast iron. The reason for this practice was given by Mr. Parsons in his reply to the discussion of his paper on "The Compound Steam Turbine and its Theory as applied to the Working of Dynamo Electric Machines," read on Dec. 19th, 1887, before the North East Coast Institution of Engineers and Shipbuilders. The reference to the matter in the Proceedings of the Institution is as follows:—"In reply to Mr. Holmes' question whether wrought iron had been tried for the magnets, he might say that with cast iron magnets only 2¼ per cent. of the energy of the dynamo was used to keep up the magnetism, which was a very small loss as compared with other dynamos. If wrought iron were used this loss might be slightly reduced, but the defect common to most dynamos, viz., difficulty in starting the magnetism, would be incurred. This defect necessitated some caution to see that the speed of the engine did not become too great before the magnetism took up, otherwise any lamps that happened to be on the circuit would be burnt up. This defect never occurred with cast iron magnets, which could always be relied on to start at once."

(To be continued.)

Naval Construction in 1933.

By HECTOR C. BYWATER, A.I.N.A.

OUTSTANDING events of the year in the province of naval construction were the completion and trials of H.M. cruisers "Leander" and "Achilles," the first ships of the new 7000-ton class; the introduction of a large building programme by the United States, embracing thirty-two vessels, estimated to cost £55,000,000; and an Admiralty announcement to the effect that the cruiser programme for 1933 had been altered from three ships of 5200 tons and one of 7000 tons to two ships of about 9000 tons and one of 5200 tons. The reasons for this important modification are set forth below. During the year work has continued on the French battle-cruiser "Dunkerque," but at such a leisurely pace that her launching date remains indefinite. As the only true capital ship now building anywhere in the world, this vessel is naturally an object of interest. Germany launched her second miniature battleship on April 1st as the "Admiral Scheer," and on the same day the prototype, "Deutschland," was formally commissioned for service. With the passage of time the enthusiasm which this novel type aroused in technical circles has somewhat diminished, and the so-called "pocket battleships" are now regarded in their true light as an audacious experiment, the success of which has yet to be demonstrated. The silence which the German authorities have observed in regard to the "Deutschland's" trials may not be without significance, though the high reputation enjoyed by German shipbuilders and engineers, not least in connection with the development of marine oil engines of large power, renders it probable that the 56,800 B.H.P. Diesel plant installed in the "Deutschland" has fulfilled expectations. Sweden has launched the cruiser seaplane carrier "Gotland," the first vessel of this type to be built. For the rest, the United States is now the only country in which 10,000-ton cruisers of the Washington Treaty type are still being constructed. Elsewhere the type has fallen into disrepute on account of its high cost and extreme vulnerability. The semi-official description of the latest U.S. 10,000-ton 8in. gun ships as "armoured cruisers" is clearly a misnomer. In a ship of this displacement, with engines of 107,000 H.P. and an armament of nine 8in. 30-ton guns plus eight 5in. anti-aircraft pieces, the margin of weight left over for protection must be very narrow. Such armour plate as is fitted must be comparatively light, and it is probably as true of these ships as of the British "County" group that one salvo of 8in. shell, or a single torpedo or mine, would suffice to disable, if not to destroy.

British Empire.

In the House of Commons on November 15th the First Lord of the Admiralty made a statement which may be summarised as follows:—The 1933 programme included one "Leander" class cruiser of 7250 tons and three "Arethusas" of 5400 tons each, armed respectively with eight and six 6in. guns. "The policy of building cruisers of comparatively small tonnage had been adopted in the hope that other nations would follow our lead." It had been learned, however, that Japan had six cruisers of 8500 tons, each mounting fifteen 6in. guns, building or projected, while the United States had legislated for four 10,000-ton cruisers, also to be armed with fifteen 6in. "If, therefore, our programme, already approved, were to be carried out, the new cruisers would be definitely inferior to those being developed by other Powers." As our total cruiser tonnage to be completed by 1936 is limited by the London Treaty to 91,000 tons, the Admiralty had been placed "on the horns of a very serious dilemma." They had to decide whether to go on building a larger number of inferior cruisers or to lay down fewer cruisers of heavier tonnage and stronger armament. The second alternative had been chosen, and this meant that the 1933 programme would be revised to include two new type cruisers of about 9000 tons, with increased armament, and one cruiser of the "Arethusa" type, of about 5200 tons. No increase in the cost of the programme was involved by the change.

Naval opinion as a whole has approved the Admiralty's decision. To continue building ships which in battle could not face their foreign contemporaries would be a thoroughly bad policy. The glaring fact that British statesmanship at the London Conference put this country in such a position that it must either build second-class ships, or so few of the first-class as to leave the Navy desperately short of cruisers, invites comment which would be out of place in this article. It is, however, permissible to express the hope that at the next Naval Conference, due in 1935, the vital defence interests of the Empire will not again be sacrificed to political expediency. There is, of course, much speculation as to the characteristics of the 9000-ton cruisers, which, unfortunately, are not to be laid down before next summer. They will, it is presumed, carry not less than twelve 6in. guns, and if these are all to be mounted on the centre line the adoption of triple turrets would appear unavoidable. The displacement should allow for reasonably strong armour protection.

H.M.S. "Leander," the solitary cruiser of the 1929 Estimates, was commissioned at the end of March, four years after authorisation. Her trials were protracted, but she is understood to be a very successful ship in all respects, able to attain her contract speed of 32½ knots without difficulty. The displacement is officially given as 7250 tons and the machinery develops 72,000 H.P. The ship has a very smart appearance at sea, the single large funnel, in conjunction with the superposed 6in. turrets forward and aft, giving a remarkable impression of power. Of the three similar cruisers authorised in 1930, the "Achilles"—see Supplement—built by Cammell-Laird, was commissioned in October last. In the following month she made a noteworthy voyage from Gibraltar to

Portland, covering the distance at an average slightly above 28½ knots at three-fifths full power. This, the best long-distance run at high speed hitherto recorded of any cruiser of corresponding tonnage, British or foreign, reflects great credit alike on the machinery contractors and the engineering department of the ship. The "Orion" began her trials in October, but had to interrupt them owing to a slight defect in the turbines, which took ten days to adjust. The full-power and other steaming trials have since been completed satisfactorily. The third ship, "Neptune," is still undergoing trials. The 1931 group of cruisers comprises the "Amphion" and "Ajax," of the "Leander" class, and the "Arethusa," the first of a new 5400-ton class, armed with six 6in. guns. All three ships, the laying down of which was greatly delayed, will take the water this year, the "Arethusa," building at Chatham, being the first to leave the ways. She should be followed by the "Ajax," which Vickers Ltd. are constructing at Barrow, and then by the "Amphion," whose keel was laid at Portsmouth last June. Although very similar to the "Leander" in size, armament, &c., the wider spacing of their boiler-rooms will give the "Amphion" and "Ajax" two funnels apiece. The three cruisers of the 1932 programme are the "Phaeton" (Swan, Hunter and Wigham Richardson) and "Apollo" (Devonport), of the improved "Leander" class, and the "Galatea" (Scott's Shipbuilding Company), which is a replica of the "Arethusa." The two 9000-ton ships and the "Arethusa" unit of the 1933 programme are all to be contract built and the orders will probably be placed in March.

The flotilla leader "Exmouth" and eight "E" class destroyers of the 1931 programme are due for completion this year. Except for a slight increase in displacement, they are repetitions of the "A" class, built in 1928, which set the prevailing standard for British destroyers. The latest boats are of 1375 tons, with machinery of 34,000 H.P. for 35 knots, and an armament of four 4·7in. guns and eight 21in. tubes. Probably no better type exists for all-round service, but just as we have been forced by foreign competition to increase the tonnage and armament of our cruisers, so we may eventually be compelled to build heavier destroyers to hold the balance against the formidable craft now being constructed abroad, and exemplified by the U.S. 1850-ton leaders and 1500-ton destroyers, mounting 5in. guns; the French leaders of 2600 tons, with five 5·5in. guns; and the Japanese destroyers of 1700 tons and six 5·1in. guns. The flotilla leader "Faulknor" and eight "F" class destroyers were contracted for last May, presumably as "repeats" of the "E" boats. A landmark in submarine development was established during the year by the "Thames," built under the 1929 Estimates by Vickers-Armstrongs. Inaugurating the "River" class, this vessel has a surface displacement of 1805 tons, the length being 345ft. and the beam 28ft. Her oil engines, built to a design jointly worked out by the Admiralty and Vickers, are of 10,000 B.H.P., for a contract speed of 21¾ knots. On her trials, however, the "Thames" reached 22½ knots, a velocity never before attained by a submarine propelled by I.C. engines. The "Severn" and "Clyde," of the same class, are also building at Barrow. The submarine minelayer "Porpoise," of 1500 tons, was completed during the year at Chatham, where her sister boat "Grampus" is on the stocks. Of the medium coastal type, "Swordfish" class, seven boats have been completed and laid down to date, and two more are projected. Displacing only 640 tons, these boats are too small for overseas duty, but within their limitations they should prove useful additions to the Fleet. The speed of 13¾ knots seems inadequate, but the armament of six tubes concentrated in the bows is formidable. A great advantage of the type is its low cost compared with that of the 1450-ton "Overseas" class which preceded it.

The sloops "Grimsby" and "Leith" have been launched at Devonport. Slightly heavier than the "Sandwich" class, sixteen of which have been built, their tonnage is 1060 as against 1025; the speed remains at 16 knots, but two 4·7in. guns have been mounted instead of 4in. Under the 1931–32 programmes four sloop minesweepers are in hand—"Halcyon," "Skipjack," "Harrier," and "Hussar." They are craft of 875 tons and 16 knots speed, mounting two 4in. guns. The "Bittern," convoy sloop, and "Kingfisher," coastal sloop, both of the 1933 programme, were ordered in the autumn. No details are available, but the "Bittern" is understood to be a larger vessel than any sloop we have built since the war. Having regard to the acute shortage of cruisers, it is important that the sloops which deputise for them should be reasonably large and powerful vessels. Unfortunately, that cannot be said of the sloops now in service or building. Doubtless for reasons of economy, their dimensions are too small to permit of the mounting of a really effective armament, and the only wartime duty they could perform efficiently is that of sweeping mines. While it is true that the sloop can never replace the cruiser proper, there is no good reason why it should not be made capable of undertaking the vitally important task of convoy protection, a duty for which our present sloops are quite unsuitable. At a comparatively small extra cost we could build sloops which would not only uphold in time of peace the prestige of the flag more worthily, but in war would afford real protection to ocean convoys, even against heavily armed submarines and surface corsairs of the "Moewe" type. And an unlimited number of such vessels might be built without any infraction of treaty obligations. Looking abroad, we see such sloops as the French "Bougainville," a ship of 1968 tons, a speed of 15½ knots, and an armament of three 5·5in. guns, and the recently completed Netherlands vessel "J. V. van Nassau," of 1520 tons, 15 knots, and three 5·9in. guns. It is certainly not beyond the capacity of our naval architects to design a sloop of less than 2000 tons, with a speed sufficient for convoy work, say, 16–17 knots; a battery of three 6in. guns, a cruising radius of 5000 miles, and some armour protection. Half a dozen of these vessels could be built for the price of a 7000-ton cruiser. Useful enough in peace, they would be invaluable in an emergency. The "Bittern," now on order with John Brown and Co., Ltd., may prove to be the forerunner of such a class.

United States.

Last June President Roosevelt authorised a building programme as part of his national industrial recovery scheme. It comprises thirty-two vessels, and is estimated to cost about £55,000,000. The programme is to be completed within three years, and all contracts had been awarded before the end of August. American shipyards are therefore facing a period of prosperity. As the new programme overlaps a considerable amount of tonnage authorised previously, it will be more convenient to deal with the United States construction now in hand as a whole. On January 1st, 1934, the following vessels were on the stocks or completing afloat:—Three aircraft carriers, "Ranger" (13,800 tons), "Yorktown," "Enterprise" (each 20,000 tons); seven 10,000-ton cruisers with 8in. guns, "New Orleans," "Astoria," "Minneapolis," "Tuscaloosa," "San Francisco," "Quincy," "Vincennes"; four 10,000-ton cruisers with 6in. guns, "Savannah," "Nashville," "Brooklyn," "Philadelphia"; eight flotilla leaders of 1850 tons; twenty-four destroyers of 1500 tons; six submarines; two gunboats. Of these fifty-four vessels, the following are building by contract:—Three aircraft carriers, three 8in. cruisers, two 6in. cruisers, sixteen leaders and destroyers, and three submarines. The remaining vessels have been allotted to the Navy Yards at New York, Philadelphia, Boston, Norfolk, Mare Island, and Puget Sound. Mr. Swanson, Secretary for the Navy, stated in November that over a hundred additional vessels must be built to bring the United States Navy up to treaty strength. Whether or no those extra ships are to be built, the current programme is evidence of national determination to create and maintain a fleet of the first rank. To this policy no exception can justly be taken abroad.

The "New Orleans," to be commissioned this month (January), is the eleventh U.S. cruiser of the 10,000-ton, 8in. gun type to be completed. She differs from her predecessors in having the forecastle deck brought well aft, the bow has no pronounced overhang, and pole masts have taken the place of tripods. A belt of thin armour is reported to extend over two thirds of the water line, weight having been saved by the use of electrical welding wherever possible and the adoption of a lighter type of 8in. gun. Despite these improvements, however, the "New Orleans" perpetuates in large measure the inherent faults of her type, presenting as she does a large and inadequately protected target to gunfire and torpedo attack. Four further units of this class—"Astoria," "Minneapolis," "Tuscaloosa," and "San Francisco"—are due for completion in the present year. The "Quincy" was begun in 1933, and the keel of the "Vincennes" was laid on January 1st, 1934. This will leave only one more ship to complete the American quota of eighteen such vessels, as against thirteen British and eight Japanese.

Of greater interest, perhaps, are the four 10,000-ton "light cruisers," of the "Savannah" class, building under the new programme. Their design was the subject of representations made at Washington in September by the British Government, which drew attention to the fact that the building of such large vessels was liable to stimulate competition. Great Britain has all along been anxious to restrict future cruisers to 7000 tons, which she regards as adequate to fulfill all the duties of their type. Beyond exciting some resentment in the American Press, this *démarche* appears to have had no effect. The "Savannah" and her sisters are being built to the original design, and as 8in. guns are disallowed by treaty, they are to have the imposing armament of fifteen 6in. guns, presumably mounted in triple turrets. There is an unconfirmed report that one of the group may have a partial flight deck for aircraft, her armament being reduced to nine 6in. So far, however, no official details have been disclosed.

The aircraft-carrier "Ranger" is to be delivered on May 1st, her launch having taken place on February 25th, 1933. The length is 727ft. on the water line, the beam 80ft., draught 19ft., and the displacement 13,800 tons. The ship is propelled by geared turbines of 53,500 S.H.P., but her contract speed is not yet public. She has hangar stowage for seventy aircraft. The original design provided for outboard smoke-ducts, but it has since been decided to fit a funnel and an "island" superstructure on the extreme starboard side of the flight deck. The armament consists of eight 5in. A.A. guns. The "Ranger" is interesting as an example of the medium-size carrier, of which H.M. ships "Argus" and "Hermes" and the Japanese "Hosho" and "Ryujo" are earlier specimens. The new U.S. carriers "Yorktown" and "Enterprise," now on the stocks at Newport News, are much larger ships, the displacement being 20,000 tons. Beyond this no particulars have been released.

Eight flotilla leaders building under the new programme will be the first vessels of this type in the U.S. Navy. Conforming to the maximum size permitted by treaty they displace 1850 tons; the contract speed is 37 knots, and the armament includes six 5in. guns and eight tubes. The twenty-four destroyers appear to be uniform in design: 1500 tons, 37 knots, five 5in., 40-cal. guns, eight tubes. In all these vessels the cruising endurance is exceptionally high, 6000 miles at economical speed in the destroyers and probably more in the leaders. They compare well with the big Japanese destroyers of the "Fubuki" class, to which, in some measure, they probably constitute a reply. All six submarines now building are boats of about 1300 tons, the construction of submarine cruisers, such as the "Argonaut," "Narwhal," and "Nautilus"—2700 tons, two 6in. guns—having been suspended.

Except in so far as the new 6in. gun cruisers appear, to British eyes, needlessly large, the new U.S. programme is a well-balanced piece of legislation, framed on sound technical lines dictated by purely service requirements and unhampered by the political considerations which have restricted both the number and fighting power of recent British warships.

No review of U.S. naval building would be complete without some reference to the large scheme of battleship modernisation which is now within sight of completion. On each of the last five ships to be dealt with a sum of £3,000,000 is to be spent, bringing the total bill for renovating fifteen battleships to approximately £38,000,000, equivalent to the cost of five "Nelsons." The expenditure of this enormous sum indicates the value which American naval opinion attaches to a well-found battle fleet. In every case reconstruction has involved the fitting of bulges and additional armour, and in some instances an increase in gun elevation and an entirely new machinery outfit. In the "New Mexico," for example, the original turbo-electric drive is being replaced by geared turbines. As a result of this thorough-going modernisation the U.S. battle fleet must now be rated well above its paper strength, and may, indeed, be considered the most formidable in existence.

Japan.

No large ship went afloat during the year, and the only one to be completed was the aircraft carrier "Ryujo." This vessel, launched at Yokohama in April, 1931, has the following characteristics: Length, 548ft.; beam, 60ft. 6in.; draught, 15ft. 4in.; displacement, 7600 tons. She is driven by geared turbines developing 40,000 S.H.P., her speed being 25 knots, and is armed with twelve 5·1in. A.A. guns on twin mountings. Her aircraft capacity has not been divulged. In appearance she is a miniature "Akagi," smoke being ejected from horizontal ducts. The cruisers "Mikuma" and "Mogami," the first two of a group of six, will be launched shortly. In common with all recent Japanese cruisers they embody novel features. It is probably not too much to assert that these ships are directly responsible for the design of the American 10,000-ton, 6in. gun cruisers, and indirectly so for that of the new British 9000-ton class. The following details of the "Mogami" are understood to be official: Length, 625ft.; beam, 59ft. 6in.; draught, 14ft. 8in.; displacement, 8500 tons. Machinery, 90,000 S.H.P. for 33 knots. The armament, originally returned as fifteen 5·1in., is now known to consist of that number of 6·1in. guns disposed on the centre line in triple turrets. On paper, at least, the ship appears to be over-gunned, and if the engine power is accurately stated, there can be little or no weight to spare for armour protection. Japanese designers have in the past displayed much ingenuity in compressing great fighting power into moderate displacement, and it may, therefore, be prudent to withhold criticism of the "Mogami" and her consorts until their performance is known.

All twenty-four "super-destroyers" of the "Fubuki" class have been launched. As they were fully described in last year's review, it need only be said that they are ships of 1700 tons and 35 knots, armed with six 5·1in. guns and nine 21in. tubes, and notable in having the guns paired in closed turrets and splinter-proof hoods over the torpedo tubes. I am informed by a Japanese naval officer that this unusual arrangement was adopted after a searching investigation by the Japanese naval staff of destroyer tactics in the Great War. Apparently, it is intended to prevent the summary disablement of gun crews and torpedo parties by shell splinters. At the other extreme, from the viewpoint of size, are the new torpedo-boats of the "Chidori" class, four of which are completing afloat. They are boats of 527 tons, with a speed of 26 knots, and are armed with three 5·1in. guns and four tubes. It would not be unreasonable to describe

them as lineal descendants of the British "P" boats of 1917, which were intended primarily to hunt submarines. In view of the heavy weather often encountered in Japanese waters, the tactical value of these little craft must needs be limited. Five submarines, of 1975 to 1430 tons, are under construction. A large "replenishment" programme is now under consideration, but has not been adopted at the time of writing. New construction already in hand or shortly to be started embraces, apart from cruisers, twelve 1400-ton destroyers, six submarines, one large and three small minelayers, and various nondescript vessels.

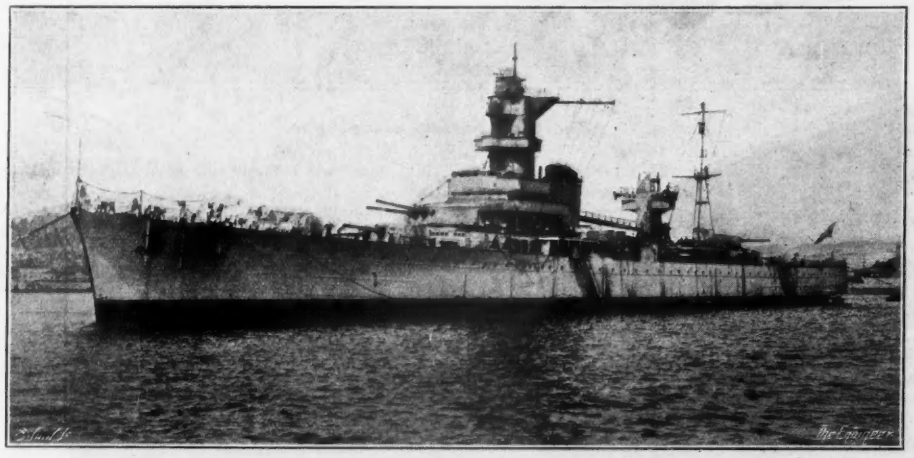
France.

Some further details of the "Dunkerque" have been published in the French papers. Although this vessel was begun at Brest in December, 1932, she is reported to be making such leisurely progress that the launching date cannot yet be fixed. The official dimensions are:—Length, 689ft.; beam, 98·4ft.; displacement, 26,500 tons. Machinery: geared turbines of 100,000 S.H.P.; contract speed, 29½ knots. The main armament of eight 13in. (33 cm.) guns is grouped forward in two quadruple turrets, each pair of guns in the turret forming an autonomous unit, divided from the other pair by a massive bulkhead. In effect, therefore, the quadruple gun-house represents twin turrets mounted on a common turntable. All eight guns have a wide arc of training abaft the beam. Sixteen 5·1in. (13 cm.) guns constitute the secondary armament, mounted in two double and three quadruple turrets. The main armour belt, which begins at the base of the foremost turret and is carried aft to within about 150ft. of the stern, is 10·8in. on the water line. Above this belt there is an armour deck 4·9in. thick, and below it a second deck of 2in. plating. Armoured longitudinal bulkheads are worked over the greater part of the ship. The total weight of armour is said to be 10,000 tons. If this be true the percentage of protection to displacement is higher than in any previous ship of war. It is clear from these revised details that the "Dunkerque" will be much more formidable than the first reports indicated. Although officially rated as a *cuirassé*, or battleship, her attributes are those of a battle-cruiser second in fighting power only to H.M.S. "Hood."

The "Algérie," completed at Brest in the autumn of 1933, is the seventh, and probably the last, of the French 10,000-ton "Washington" cruisers. Although the speed has been reduced to 32 knots, she is patently superior in military value to her predecessors. The weight saved in machinery has been put into protection, consisting of a broad 4in. belt over some three-fifths of the water line and spanned by an armour deck; further, the subdivision to localise torpedo damage has been improved. In place of a foremast the "Algérie" has a large control tower, which appears to be a modified version of H.M.S. "Nelson's" famous structure. "La Galissonnière," first of a class of six cruisers authorised in 1930–32, was launched at Brest on November 17th. The dimensions, &c., are:—Length, 590·5ft.; beam, 57·4ft.; draught, 16·4ft.; displacement, 7729 tons. Machinery: geared turbines of 84,000 S.H.P. for 31 knots. As in the case of the "Algérie," a reduction in speed has been accepted for the sake of improved armour protection, which is designed to resist 6in. shell fire. The main armament is nine 6·1in. guns in triple turrets, two forward and one aft; eight 3·5in. A.A. guns, and four 21·6in. torpedo tubes. Two seaplanes will be carried. The design of this ship is eminently workmanlike and thorough, a remark that applies equally to almost all the post-war vessels of the French Navy. A sister ship, "Jean de Vienne," is shortly to be launched at L'Orient, and the "Gloire," "Marseillaise," "Montcalm," and "Georges Leygues" are building in private yards. France has done well to perpetuate in the last-named cruiser the memory of her great Minister of Marine, who died last year, since to him, far more than to any other individual, she owes the rebirth of her national sea power.

The cruiser minelayer "Emile Bertin" went afloat at St. Nazaire on May 9th. If she comes up to expectations she will be one of the most remarkable ships of the day. This is what her designers have put into a hull 548ft. long and 52ft. 6in. broad, drawing 16·4ft. on a displacement of 5886 tons:—Machinery of 102,000 S.H.P. for a speed of 34 knots; an armament of nine 6·1in. guns in triple turrets, plus twelve light A.A. guns and six torpedo tubes, and a large outfit of mines with laying gear. And in addition to all this an electrically welded armour deck has been worked over the vitals of the ship and provision made for a catapult and seaplane. If the steam and gunnery trials of this ship are successful she will represent a new triumph for French naval architecture.

Several flotilla leaders of the belated 1930 programme took the water during the year. Officially listed as *contre-torpilleurs*, these vessels are cruisers in all but name, and are rated as such by the London Treaty. "Le Malin," launched in August, and "L'Indomptable," in November, belong to the new two-funnelled class, in which the displacement has been increased from 2440 tons to 2570 and the S.H.P. output from 70,000 to 75,000, raising the speed from 36 to 37 knots. The gun armament is the same as in the preceding class, viz., five 5·5in., but nine torpedo tubes are carried instead of seven. Thirty-one of these exceptionally powerful ships have been laid down to date, the smallest being the six "Chacals," of 2126 tons and 35½ knots. All have exceeded their contract speeds on trial, in some cases by as much as five or six knots. The "record" is held at present by the "Cassard," which reached 42·9 knots, while the "Gerfaut," "Epervier," and "Milan" have all steamed at more than 42. It is worthy of note that these vessels do not serve as flotilla leaders, but are organised in divisions. This suggests that they are intended to be used as light cruisers rather than as torpedo craft. The only destroyer proper now building in France is "Le Hardi," an experimental boat credited with a displacement of 1600 tons. A group of twelve torpedo boats, officially designated *escorteurs* (convoy guards) is under construction in private yards. The displacement is 600 tons, the length 236·2ft., the contract speed being 35 knots. Two 3·5in. and some smaller guns, with four 15·7in. torpedo tubes, comprise the armament. These craft should be useful for patrol and anti-submarine duties, and they are of interest as marking a return to true torpedo boat design. In spite of delays in the building programme the French submarine force continues steadily to grow in strength. Thirty boats of the well-tried "Redoubtable" class are now completed or building, hardly any modification having been made in the original design: 1644 to 1678 tons surface displacement, 18 knots, one 3·9in. gun and eleven tubes. Many of the boats have made long voyages and are capable of remaining at sea for a month. They are larger editions of the "Requin" class (nine units), and appear to be thoroughly successful craft. A large number of coastal boats, ranging from 558 to 571 tons, are still in hand, and eventually thirty-one will be completed. Excluding over-age boats, the French Navy now has eighty modern submarines ready or constructing, a total exceeding that of any other navy.



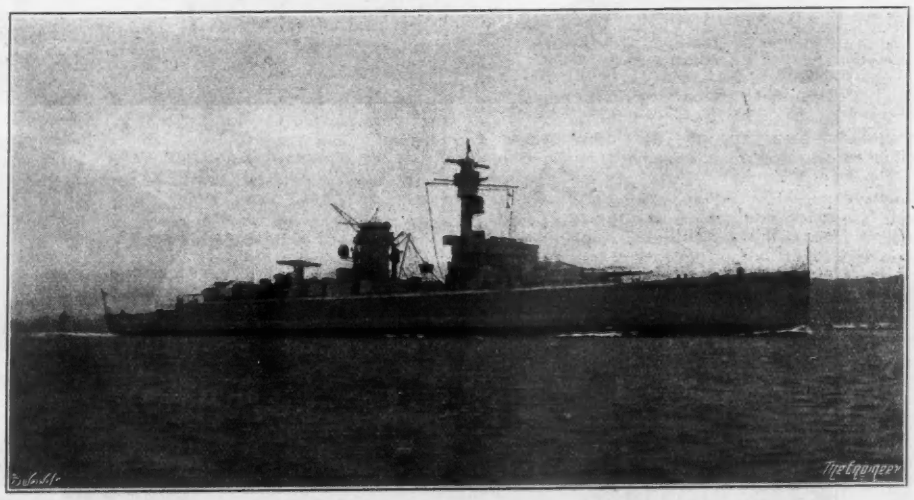
THE FRENCH 10,000-TON CRUISER "ALGERIE"

Italy.

The "Bolzano"—see Supplement—the seventh 10,000-ton "Washington" cruiser, was completed by Ansaldo during the year. In this ship there has been a return to the very high speed, 35·5 knots, achieved in the "Trieste" and "Trento," at the sacrifice of that substantial armour protection which is a feature of the intervening 32-knot vessels, "Zara," "Fiume," "Gorizia," and "Pola." Now that Italy has gained numerical equality with France in this type of ship, it is unlikely that she will build any more. Her naval architects are concentrating on the development of the "Condottieri" class of light cruisers, twelve of which have been laid down since 1928. There has been a progressive increase in displacement, from 5070 tons to 7000, with a corresponding advance in S.H.P. to maintain a uniform speed of 37 knots. The armament remains unchanged at eight 6in. guns. On trial, the earlier ships have steamed at 39 to 40 knots, thus establishing a new record for cruisers. Besides their other qualities, they are exceptionally handsome ships, bearing all the marks of bold yet careful design. Four destroyers of 1449 tons, with a contract speed of 38 knots, are in hand. They will complete a fairly homogeneous flotilla of twelve boats distinguished by their large single funnels. Since completing the twelve 1628-ton vessels of the "Navigatori" class three years ago, Italy has made no further attempt to reply to the huge French leaders. Eight submarines, the largest a minelayer of 1393 tons, are building.

Other Navies.

The Swedish "aircraft cruiser" "Gotland" was launched on September 14th. She was briefly described in last year's review, but the novelty of her design merits a further short notice. She is 426ft. 6in. in length, 47ft. 9in. in beam, and draws 16ft. on a displacement of 4600 tons. The machinery consists of two sets of de Laval geared turbines taking steam from four small tube boilers and developing 33,000 S.H.P. for 27 knots. A considerable amount of light armour has been worked in to protect the waterline, boiler uptakes, and gun positions.



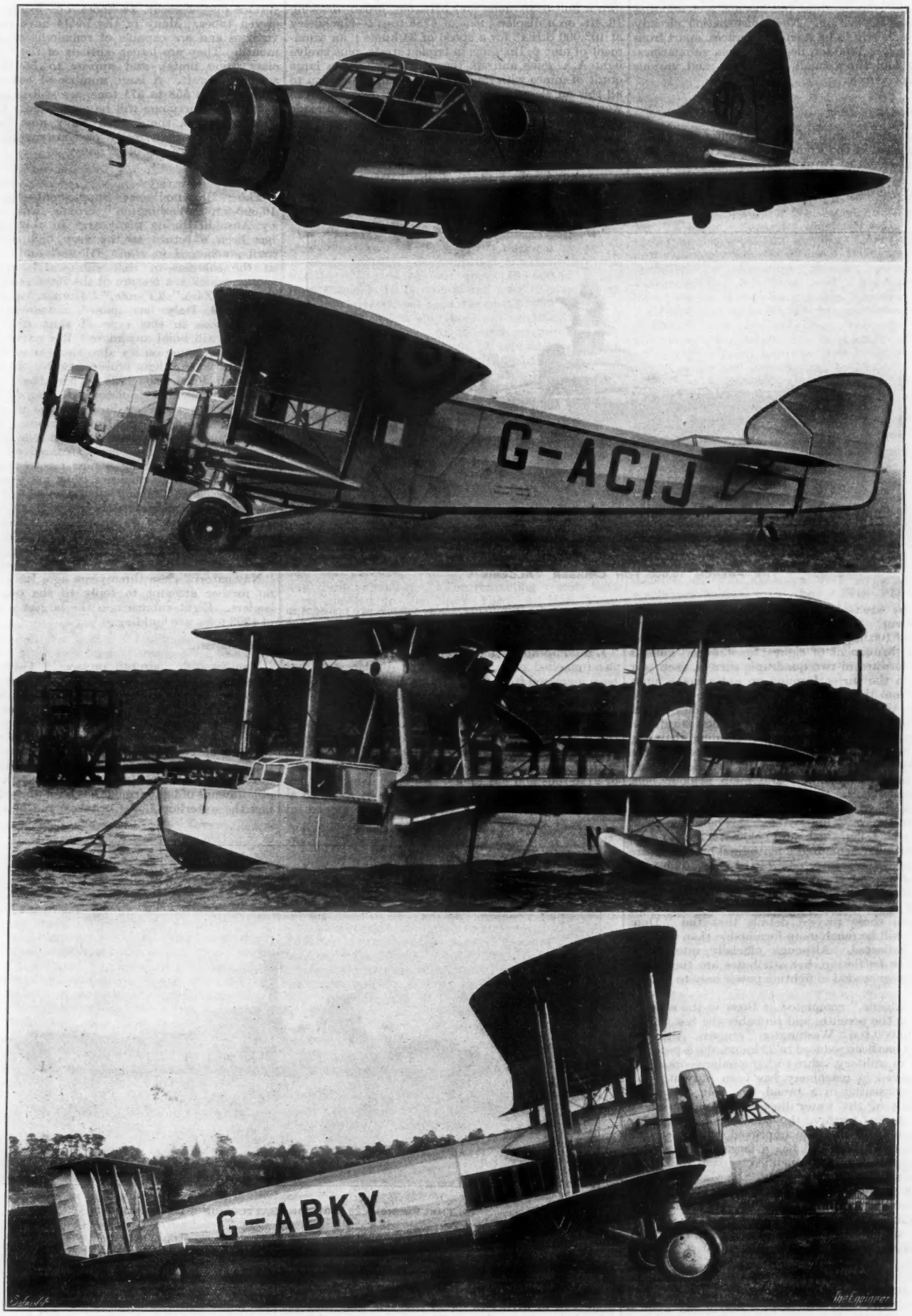
THE FRENCH 26,500-TON BATTLESHIP "DUNKERQUE"

Six 6in. guns are mounted, four in double turrets at bow and stern, and two in single turrets on the beam abreast of the bridge. The after part of the ship, representing one-third of the total length, is reserved for a catapult and seven or eight seaplanes. Much ingenuity has been displayed in the arrangement of armament and aircraft equipment. A vessel of this type would be a valuable adjunct to any fleet, and it will not be surprising if the basic design reappears in modified forms in other navies.

After trials lasting five months the German *Panzerschiff* "Deutschland" was commissioned on April 1st. No official details of the trials have been released. On the same day a sister ship "Admiral Scheer," was launched at Wilhelmshaven. A third unit, "Ersatz Braunschweig," is to be launched this

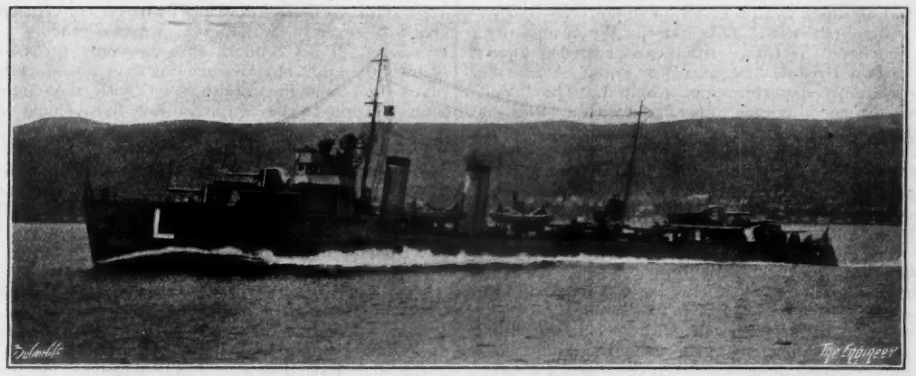
AIRCRAFT OF 1933

(*For description see opposite page.*)



1.—AIRSPEED "COURIER" PASSENGER CARRIER
2.—WESTLAND WESSEX 8-SEATER MONOPLANE
3.—SUPERMARINE "SEAGULL" Mk V. AMPHIBIAN FLYING BOAT
4.—VICKERS "VELLOX" PASSENGER, MAIL AND FREIGHT CARRIER

spring, and a fourth "Ersatz Elsass," will be laid down at an early date this year. The class has been exhaustively described in previous annual reviews, and there is little new to report beyond an increase in the torpedo armament. This now consists of eight tubes on quadruple carriages, one at each side of the quarterdeck, each mounting fitted with an armoured hood to protect it from the blast of the after 11in. turret.



PORTUGUESE DESTROYER "LIMA"

British industry is playing a prominent part in the rebuilding of the navy of Portugal, our oldest ally. Two sloops—see Supplement—which almost deserve promotion to the cruiser category, are building by Hawthorn, Leslie. They are trim little ships of 2100 tons, with turbine machinery of 8000 S.H.P. = 21 knots, and an armament of four 4·7in. guns, two 3in. A.A. guns, and accommodation for forty mines. The same firm delivered to the Portuguese Government last year two smaller sloops, and Yarrows completed the destroyers "Vouga" and "Lima," which closely resemble the latest British type. Vickers-Armstrongs are completing three Portuguese submarines of 854 tons surface displacement. These contracts are another indication of the tendency of foreign Governments again to make use of the unrivalled resources of the British shipbuilding and armament industry when it is a question of augmenting their naval forces with material of the highest class.

Aeronautics in 1933.

No. I.

FROM the report given below of the activities of the British aeronautical industry during 1933 it may be inferred that the past year witnessed a well-sustained level of occupation, but saw few or no outstanding developments on the technical side. The progress which we record, it will be found, lay almost entirely in improvements of detail. There are few completely new designs of aircraft to place on record. Nearly all represent the development of previous designs modified either in the direction of fitting them with the latest type of engine or in the direction of adapting them for duties other than or additional to those for which they were originally produced. It must not, however, be forgotten that the record which we can present is of necessity incomplete, and that it possesses a considerable time lag. Official secrecy, on the one hand, and, on the other, the understandable desire of a manufacturer not to talk about his latest design until it has been tested in the air, combine to prevent our presenting at the present moment a true picture of the technical progress made during 1933. Sufficient can, however, be revealed to show that in the main the year saw a continuation of the movement, noted twelve months ago, towards a consolidation and improvement of existing designs rather than the development of radically new ideas.

On the aero-engine side of the industry, there would appear to be evidence of more fundamental development than on the aircraft side. In particular, the advent of the compression ignition engine and the sleeve valve engine fall to be mentioned in the record of the past twelve months. It is not, however, wholly just to ascribe these engine developments to 1933, for they actually represent the culmination of work which has been proceeding quietly but continuously for six or eight years. The fact remains, however, that in 1933 the experimental investigations with single-cylinder units operating on these two principles reached a stage which justified the construction of complete engines and their testing on the bench and in the air.

If the year were not very distinguished on the side of technical development, it is still possible that in time to come it will be seen to have had much historical importance from the political point of view. To what extent the failure of the nations to reach, for the time being at any rate, agreement on the question of disarmament will react on the aeronautical industry, it is still too early to say. We can but record the failure as an outstanding event of 1933, and note that it led Great Britain to revise her attitude towards the aerial side of her defences. This country ended the war supreme in the air over all other nations. To-day, judged on the standard of the number of machines possesssed, she occupies fifth, or perhaps sixth, place. That position has come about neither accidentally nor by lack of energy, but as a result of the deliberate policy of successive Governments in this country. Britain has done her utmost to induce the other Great Powers to disarm, and, particularly in the air, has endeavoured to set them an example by reducing her air force to a low level of numbers. The other Powers, however, have failed to follow her lead. Our position of inferiority is not to be permitted to continue. In December the Government announced that while it would continue its efforts to secure disarmament, it would take steps to ensure that this country's aerial force would be not inferior to that of the strongest of the other Powers. In the present temper of the Continental nations there can be no doubt that the implementation of this policy will involve an expansion of Britain's strength in the air, for there is as little evidence as ever of willingness on the part of other Powers to reduce their strengths down to parity with ours as at present established.

THE BRITISH AERONAUTICAL INDUSTRY.

We now proceed to review in detail the work and activities of British aeronautical firms during the year.

Hawker Aircraft, Ltd.—Under this new title the H. G. Hawker Engineering Company, Ltd., of Kingston-on-Thames, was reborn in May, 1933, as a public company. The works during the past twelve months were very busily employed on machines for the re-equipment of the Royal Air Force and for foreign Governments. Seven different types of aircraft were in production for the Royal Air Force, namely, the "Hart" day bomber, the "Audax" army co-operation machine, the "Demon" two-seater fighter, the "Hart" advanced training machine, the "Fury" interceptor fighter, the "Nimrod" single-seater ship fighter, and the "Osprey" fleet fighter reconnaissance machine. All these machines are equipped with the Rolls-Royce "Kestrel" engine and are constructed throughout of metal. The two last-named types have interchangeable float undercarriages and are provided with catapulting attachments. In addition to these machines, the company delivered "Hart" machines to Sweden, "Nimrods" to Denmark, and "Audax" and "Fury" machines to Persia, while further orders from three other foreign Governments are in hand.

On the experimental side the most noteworthy event was the production of the high-speed "Fury" fighter fitted with a modified "Kestrel" engine. This machine is a development of the earlier type of the same name, and is illustrated in the Supplement. It has a top speed of 250 miles an hour, and can climb to 20,000ft. in an appreciably reduced time. It is claimed to be the fastest military machine in the world. Its improved performance has been achieved without sacrificing any of its other qualities. A departure of considerable interest was established by the delivery of stainless steel aircraft to the Fleet Air Arm. These machines are of stainless material throughout. A considerable amount of research work was carried out by the firm on evaporative cooling and definitely satisfactory results were obtained.

The Gloster Aircraft Company, Ltd.—Among the activities of the Gloster Aircraft Company the production of the Gloster "Gauntlet" day and night fighter, illustrated in the Supplement, may be accorded first place. This type of machine is to be distinguished from the short-range interceptor fighter, which generally has less than half the duration and load-carrying capacity of the day and night fighter. The "Gauntlet" machine, with the exception of the wing and fuselage coverings, is constructed of metal, principally of high-tensile steel strip formed into square or round tubes and other sections. It is driven by a Bristol "Mercury" engine, which gives it a speed of 216 m.p.h. at a height of 16,500ft., and enables it to climb to 20,000ft. in 11¾ min. The service "ceiling" is 33,000ft., or well over 6 miles. Provision is made for the machine to carry 81 gallons of petrol, 6 gallons of oil, two Vickers guns, 1200 rounds of ammunition, four 20 lb. bombs, wireless reception and transmission apparatus, and oxygen equipment. Palmer pneumatic brakes are fitted to the wheels, which, as is now usual in high-speed machines, are shrouded and a Townend ring of aluminium alloy is applied round the engine.

The company continued to develop the Gloster-Hele-Shaw-Beacham variable pitch air screw, and has now produced and tried individual patterns to suit the "Condor," "Jupiter" VI., "Jupiter" VII., and "Kestrel" II. S engines. Altogether, these various patterns of screw have been tested in flight for a period of 234 hours, in addition to ground running covering 151 hours. The Air Ministry is at present carrying out exhaustive tests with the "Kestrel" type of air screw. This particular pattern has a diameter of 11ft. and a weight complete of 171 lb.

The Cierva Autogiro Company, Ltd.—A year ago we illustrated and briefly described the latest "direct control" type of autogiro. During the past twelve months this wingless machine was further developed, the most recent form, a two-seater dual-control pattern, being illustrated in the Supplement. This machine is not only without wings; it has no rudder, no ailerons, and no elevators. A rudder bar is provided, but it is connected only to the tail wheel, and is used for steering the machine on the ground. In the air the entire control of the motion, including turning, is obtained by tilting the axis of the three-bladed rotor. This axis is universally mounted and its setting is controlled by means of a "joy-stick," which in our engraving is to be seen as a bent arm hanging from the apex of the rotor pylon with a handle at its lower end extending into the pilot's cockpit. A socket is provided on this arm, by which an additional handle extending into the front cockpit may be attached to it. Controls are provided for governing at the pilot's will the lateral and longitudinal bias of the machine, and brakes are fitted to act on the landing wheels and on the rotor. As in all previous forms of Autogiro, the rotor is not directly driven when the machine is in flight. Its motion is derived not from the engine, but from the forward movement of the machine. For starting purposes the rotor is coupled temporarily to the engine through the agency of a clutch

This latest, or C 30 type, of Autogiro is fitted with a 140 H.P. Armstrong-Siddeley "Genet Major" engine. It has a tare weight of 1200 lb., and a fully laden weight of 1700 lb. Its performance is stated to be as follows:—

Top speed, sea level	120 m.p.h.
Cruising speed, sea level	100 m.p.h.
Minimum forward speed	15 m.p.h.
Rate of climb, sea level	900ft. per min.
Ceiling	16,000ft.
Normal take off, fully laden	12 yards
Landing run	Nil

A larger example of "direct control" Autogiro, capable of carrying five passengers, is at present under construction.

Westland Aircraft Works.—The Westland "Wallace" general purpose reconnaissance and day bombing biplane, described and illustrated twelve months ago, came into service in the Royal Air Force during the year in replacement of the Westland "Wapiti." For the Houston Mount Everest flight expedition, a standard "Wallace" machine with only a few simple modifications was chosen. The actual machine employed is illustrated in the Supplement. The engine used on this machine was of the Bristol "Pegasus" S 3 supercharged type. The flight involved an ascent, with fuel, crew, oxygen, photographic apparatus and equipment, to a height of over 35,000ft., and created an unofficial altitude record for a two-seater machine. The machine not only gave a fully successful account of itself on the actual altitude flight, but behaved with complete satisfaction during its flight across India to the scene of operations, a fact which testifies to its ability to withstand extremes of temperature without developing trouble.

The "Pterodactyl" Mark IV. tailless machine underwent considerable experimental and research work, and, we learn, interesting developments in this machine are now taking place at the Yeovil works. The three-engined monoplane known as the Westland "Wessex," was produced during the year in two forms, namely, as a six-seater, with an all-up weight of 6000 lb., and as an eight-seater, with an all-up weight of 6300 lb. The eight-seater "Wessex" machine is illustrated on page 6. It is equipped with three Armstrong-Siddeley seven-cylinder "Genet" Major engines, each of which is fitted with a Townend anti-drag ring. In addition to farther orders for machines of this type placed by Imperial Airways,

Ltd., for use on private charter flights, the "Wessex" machine was honoured by being chosen for the first air service to be operated by a British railway company, namely, that established during the year by the Great Western between Birmingham, Cardiff, and Plymouth.

Airspeed, Ltd.—The company known as Airspeed, Ltd., is a recent addition to the ranks of British aircraft manufacturers. It is established at the Airport, Portsmouth, and has Lord Grimthorpe as chairman, Sir Alan Cobham and Mr. A. E. Hewitt as directors, and Mr. N. S. Norway and Mr. A. H. Tiltman as joint managing directors. The company's first production was a triple-engined passenger carrier known as the Airspeed "Ferry," a biplane machine with a large cabin with seats for eight or ten people. From the structural point of view this machine is distinguished—for these days—by the extensive use of spruce and other woods in the construction of its main members. A later production of the company's is the "Courier," illustrated on page 6. This machine is a fast passenger-carrying monoplane, the cabin, fitted with six seats, being situated above the wings. This machine, like the earlier one, is built mainly of spruce and three-ply wood. The front end of the fuselage is, however, formed of welded steel and is integral with the engine mounting. The wing structure is a tapered cantilever with a central section permanently attached to the fuselage and two extension planes united to the centre section in a detachable manner by means of bolts. It is claimed that the whole wing structure is extremely stiff in torsion and that it is therefore able to resist "flutter" at the highest speed. The engine is an Armstrong-Siddeley "Lynx" of 240 H.P. and drives a Fairey-Reid metal screw. The cruising speed is 143 m.p.h., at which speed the normal tankage provided is sufficient for a range of 700 miles. A distinctive feature of the design is the retractor undercarriage. The undercarriage has a split axle of orthodox design and is tied by a pair of radius rods to the rear wing spar. Each radius rod is jointed towards its forward end. The joint is acted upon by a hydraulic ram supplied with oil under pressure from a hand-operated pump. When oil is pumped from one side of the ram piston to the other the radius rod is folded upwards and the undercarriage is moved into recesses in the underside of the wing. Means are provided for locking the undercarriage in either the extended or retracted position. In the retracted position about one-third of the diameter of the wheels remains below the lower surface of the wing planes. The wheels in this position are capable of rotating and of supporting the weight of the machine. If, therefore, the pilot should forget to lower the undercarriage before landing, minor damage alone would in all probability be caused. Nevertheless, precautions are taken to ensure that the carriage is extended before a landing is made. An electrical indicating system is provided, which, when a switch is operated, shows by a system of lights on the dashboard the position occupied by the landing carriage. These lights can be switched on at any time. In addition, they are automatically brought into action when the throttle is closed for a glide to land. If the throttle is closed with the undercarriage in the retracted position a high-frequency horn is sounded. The retractor undercarriage markedly reduces the resistance of the machine in flight and increases the speed obtained from a given horse-power.

Vickers (Aviation), Ltd.—At the Weybridge works the Vickers "Victoria" troop carrier was modified to take two Bristol "Pegasus" engines. A considerably improved performance resulted. The "Vildebeest" torpedo bomber, also fitted with a "Pegasus" engine, was developed as a twin-float seaplane, and as a general purpose aircraft. When the torpedo is replaced by an auxiliary fuel tank, the range of the machine is increased from 625 to 1250 miles. Further modifications permit it to be operated as a three-seater. On the civil aviation side, the latest production of the works is the "Vellox," illustrated on page 6. This machine, equipped with two medium supercharged "Pegasus" engines, can be adapted for a variety of duties. It can be arranged for long-distance mail carrying work with accommodation for three or four passengers or as a medium-distance passenger machine with eight or ten seats, a lavatory, and a mail and baggage compartment. Alternatively, it can be used as a long-distance troop carrier with accommodation for ten to fourteen troops or as a heavy freight carrier, in which arrangement it is fitted with a top loading hatch measuring 6ft. long by 4ft. 6in. wide.

At the company's Supermarine Aviation Works, Southampton, two new types of sea-going aircraft were produced, namely, the "Scapa" flying boat and the "Seagull" amphibian. The "Scapa" is an open-sea reconnaissance multi-seater twin-engined flying boat. It is fitted with two Rolls-Royce "Kestrel" engines, and represents a development of the "Southampton" flying boat with two Napier engines. The "Seagull" is an amphibian flying boat, fitted with a Bristol "Pegasus" engine, and is primarily intended for "fleet spotting" work and to operate from an aircraft carrier. This machine is illustrated on page 6. It will be inferred from the engraving that in the retracted position the wheels fit into circular recesses on the underside of the lower wings.

We have to acknowledge our indebtedness to our contemporary *Flight* for granting us permission to use the copyright photographs of the Gloster "Gauntlet" High-altitude Fighter, the Cierva Direct-control Wingless "Autogiro" and the Hawker "Fury" Single-seater Fighter, reproduced in the Supplement.

(To be continued.)

Road and Rail in 1933.

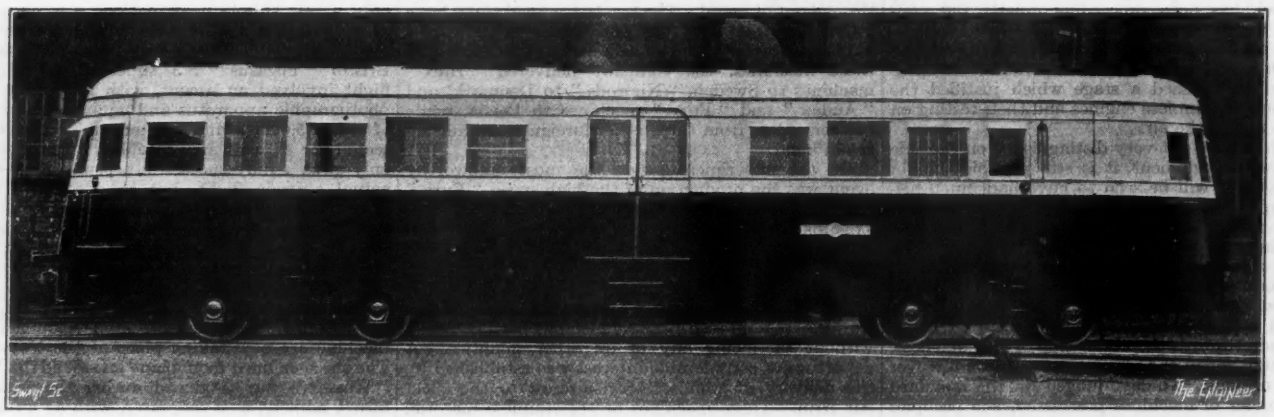
THE year 1933, so far as the road is concerned, was more notable for legislative and Government action than for any special advances in design. While there is nothing comparable to the disturbance caused by the issue of the Salter Report to record, the public has been much alarmed by the increase in road accidents, and there was for some time a feeling that the Government ought to take immediate action. The issue towards the end of the year of a Preliminary Report on Fatal Road Accidents, which dealt with the first six months of the year, by indicating that the Government had the matter under consideration and was collecting all the available data for analysis, was greeted with general satisfaction. The most notable event of the year was the formation of the London Passenger Transport Board, which took over the control of nearly all the omnibuses, the trams, and the tubes in the London area on July 1st, and will eventually control all transport within an area having a radius around Charing Cross of about 30 miles, with the exception of the suburban lines of the four great railway companies. A Joint Committee, however, having representatives from the Board and from the railways, will secure co-ordination of the services. On January 1st, 1934, new legislation, derived from the evidence of the Salter Report, came into operation, heavily increasing the taxation of large commercial road vehicles. As a result, nearly all lorry manufacturers are endeavouring, so far as is possible, to reduce the tare weight of the vehicles they construct with the object of bringing them into a lower taxation category for a given carrying power.

Other than these efforts to reduce weight, there were no startling innovations in the design of road vehicles during the year, although easy-change and self-changing gear-boxes made further progress into favour. An interesting device brought out by Leyland Motors, Ltd., is the torque converter which we described fully and illustrated in our issue of October 13th. This mechanism does away with the conventional gear-box entirely, although a reverse gear is still necessary. It is brought into use only at speeds below 20 m.p.h., by disengaging one set of clutch plates and engaging another set with the engine. Since it works to the best advantage in a vehicle that is constantly starting and stopping, the device is more likely to appeal to omnibus operators than to lorry owners. Its success or non-success will probably be judged on a basis of fuel consumption, as compared with a conventional gear-box drive, although the smoothness of the acceleration it gives must not be overlooked.

The year saw a very rapid extension of the use of signal lights at cross roads and other points, particularly those of the vehicle-actuated type. In London alone, for instance, two installations—one at Trafalgar-square and the other along the length of Piccadilly—have demonstrated conclusively the flexibility of this system of controlling traffic, and similar signals have been erected or are now in course of erection at several other points.

As a result of the development of road competition, the railways are now exhibiting great interest in railcars, and several new coaches of this type were produced and entered service during the year. These vehicles, it is hoped and believed, will provide an economical means of working subsidiary lines on which the passenger traffic is comparatively small, and which suffer severely from road competition. They are capable of high speeds and high acceleration, combined with very effective braking. While, so far as those propelled by internal combustion engines are concerned, the railway companies are not yet willing to admit them to be out of the experimental stage, manufacturers in some cases are casting forward to the possibilities of working lines with greater traffic density, and abroad, if not in this country, of operating through expresses of this type. When it is considered that railcars are a comparatively recent innovation, it is not surprising that the manufacturer and the railway company do not always see eye to eye as regards certain points of the design. As a rule, for instance, railway officials prefer a vehicle to which a horse-box or cattle trucks, &c., can be attached as and when required, while the designer of the less powerful type of railcar, desirous of making his vehicle as light as possible to obtain high acceleration, wishes to ensure that its frame will not be subjected to the strains and shocks inseparable from drawing trailers and performing shunting operations.

During the year we described three railcars. One, made by Sir W. G. Armstrong, Whitworth and Co., Ltd., and termed the "railbus," is claimed to be the lightest 60-seater self-propelled rail coach made in Great Britain. With a total weight in working order of 17½ tons, it seats seventy-one passengers, or, if a luggage compartment is included in the design, fifty-seven. It is not intended to haul trailers. With a 95 B.H.P. engine driving the wheels of the power bogie through an electric transmission system of the familiar Armstrong type, it is capable of a speed of 60 m.p.h. Electric transmission was adopted in preference to mechanical, on account of its complete flexibility and because it was believed to be less exacting on the engine than gearing. It has also the advantage that the engine, subject to the requirement of accessibility, can be placed at any convenient point, in this case in the centre of the railbus, between the underframe members and beneath the floor. As will be seen from the engraving reproduced, no attempt at full streamlining has been made, but a deep skirting surrounds the frame and the ends of the body are sloped and rounded. In distinction to normal railway



ARMSTRONG "SIXTY-SEATER" RAILBUS

practice, internal expanding Ferodo-lined brakes have been fitted. During an exhibition run on August 3rd, which we had the pleasure of attending, the vehicle performed a non-stop run from King's Cross to Hertford, and made three halts on the return journey. The fuel consumption worked out at 7·15 miles per gallon, and the coach easily kept within its time allowances.

As recently as December 22nd we described another oil-electric railcoach. This vehicle, made by the English Electric Company, Ltd., is propelled by a 200 H.P. six-cylinder oil engine running at 1500 r.p.m. By the courtesy of the L.M.S. Railway, it is being tested on various portions of the company's system

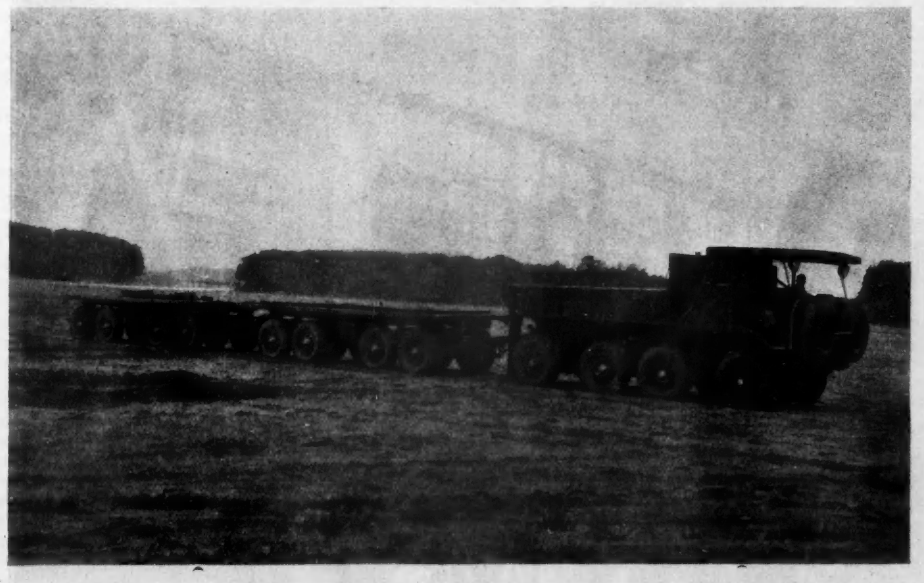
130 H.P. OIL-ENGINE DRIVEN "HARDY" RAILCAR

under service conditions, and has recently entered service on the Watford–St. Albans branch. It has a maximum speed of 60 m.p.h. and a seating capacity of fifty-three, and weighs in working order 37½ tons. This E.E.C. vehicle is adapted for hauling cattle trucks, horse-boxes, &c., when required to do so. The engine and the 135-kW generator to which it is coupled are situated in a compartment above the driving bogie, and there is, of course, a driver's control compartment at each end of the coach. During the five weeks ending November 11th, this vehicle ran 5880 miles on the Warwick–Daventry–Northampton branch of the L.M.S., drawing trailing loads sometimes, and doing occasional shunting of such loads. The average fuel consumption worked out at 6·26 miles per gallon. An illustration of this coach will be found in our issue of December 22nd.

Although the oil-electric driving system undoubtedly has advantages, it still remains to be discovered whether they outweigh the greater transmission efficiency of gearing. Had the railcar been developed a few years earlier, there is little doubt that the electric system would have won the day, purely on the score of the difficulty of changing gear in the direct system, but the advent of the self-changing gear-box has relieved the mechanical system of that incubus. That the mechanical drive has certain advantages is demonstrated by the fact that it was adopted by Hardy Motors, Ltd., for the railcar which that firm exhibited at the Commercial Motor Transport Exhibition. We described this car and illustrated the article with reproduced photographs and drawings in our issue of October 27th. It has an A.E.C. 130 H.P. oil engine and carries sixty-nine passengers. Its weight is less than 20 tons, and it has a top speed of 60 m.p.h. Without carrying streamlining to excess, its shape, as will be seen from the engraving reproduced, is such as appreciably to reduce the windage resistance. Chief interest in the design naturally centres upon the transmission system. The engine is placed to one side of the longitudinal axis of the coach forward of the central access doors, regarding the driving bogie as being situated at the rear. The transmission system is made up of a "fluid" fly-wheel, a four-speed and reverse Wilson pre-selective gear-box, a reverse gear-box, and worm drives to the two axles of the bogie. The various transmission shafts lie outside the frame of the vehicle, but are covered by the shrouding of the coach. The arrangement of the worm drive to each of the axles is of particular interest as the worm is supported in the axle-box casing outside the wheel. It was described in detail in the article to which we have referred. Like the Armstrong railbus, this coach also has been equipped with internal expanding brakes. Special arrangements had to be made for drawing cooling air through the radiator, which is situated in the conventional position in front of the engine. Immediately after the Motor Transport Exhibition closed, this railcar entered service on the Great Western Railway. During an exhibition run from Paddington, it covered the distance of 36 miles to Reading in a few seconds under 40 min., attaining a maximum speed of 61 m.p.h., and averaging over 54 m.p.h. from start to stop. The smoothness of the running and the lack of engine vibration was favourably commented upon by the passengers.

At the present moment the vehicle is temporarily out of service. It was found that when the brakes were applied, a certain amount of chatter was set up at the axle-box guides, throwing a heavy load on the torque rods, and it has been decided to make alterations with the object of suppressing this undesirable motion. The principal change now being made is the substitution of torque arms for torque rods and the introduction of hydraulic braking, the brake cylinder being mounted on the torque arm. Advantage is also being taken of the fact that the car is out of service to introduce a new type of engine suspension which has been found very successful in the "Q" type omnibus manufactured by the Associated Equipment Company, Ltd. In this type of omnibus it will be recalled, the engine is situated at the side, beneath the seats, in much the same manner as that of the railcar.

Although in this country there are few districts that cannot be served by railways, abroad, and particularly in tropical and other colonial districts, such services cannot be maintained. In many parts of the world the cost of the construction of a branch line to open up a new district is prohibitive. In such circumstances it would be thought that road vehicles would be particularly suitable. However, most of the vehicles supplied to the Colonies are more or less home designs adapted, with tropical type radiators and the like, for oversea service, and, except for the more expensively priced produce, the costs of transport per ton-mile with such lorries is excessive. During the year 1933 we described and illustrated a special vehicle designed by Hardy Motors, Ltd., for the Oversea Transport Committee, a body set up by the Government to examine the question of the design of vehicles for oversea service. This "oversea transport unit," as we termed it, is composed of an eight-wheeled tractor, of which the 130 H.P. oil engine drives all the wheels, and which carries a load of 3 tons; and two eight-wheeled trailers, each capable of carrying 6 tons, giving a total load of 15 tons in all. The tractor steers on both its front and rear axles, while the trailers are each supported on two four-wheeled bogies and are so arranged that they follow exactly in the path of the tractor, even on the sharpest turns. The object of the design is to spread the load of 15 tons over as many wheels as possible, so that the unit when travelling over the low-grade earth roads to be encountered overseas, shall have as small a tendency as possible to disintegrate them. We were fortunate in being able to witness a number of very successful trials of this unit. The trailers, it should be observed, were constructed by R. A. Dyson and Co., Ltd., of Liverpool. A photograph of the unit traversing soft sand is reproduced in an accompanying engraving.



OVERSEA TRANSPORT UNIT

OBITUARY.

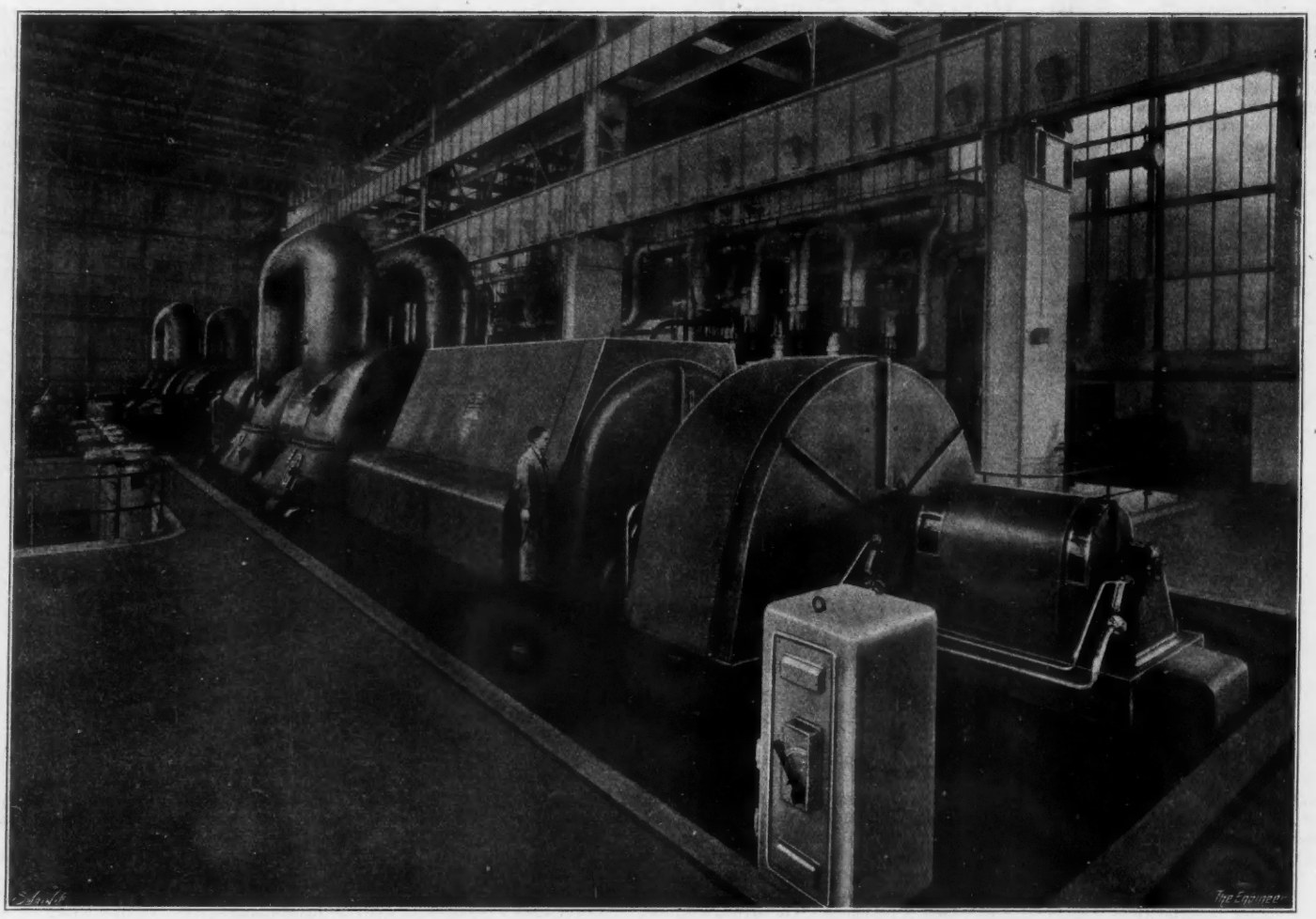
GEORGE BROWN.

SHORTLY before the end of the year the death took place in Glasgow of Mr. George Brown, the founder of the firm of George Brown and Co., of Garvel Shipyard, Greenock. Mr. Brown, who was born at Birkenhead, served his apprenticeship with Alexander Stephen and Sons, and later joined William Denny and Brothers, at Dumbarton, where he became chief draughtsman and assistant manager. In 1900 he started to build and repair ships at the Garvel Shipyard, Greenock, and although he was for a time faced with difficulties, he achieved his ambition to build small vessels of all kinds for some of the best shipowners in the world. He was a former President of the Clyde Shipbuilders' Association, a member of the Clyde Lighthouses Trust, and a member of the Institution of Naval Architects, and the Institution of Engineers and Shipbuilders in Scotland.

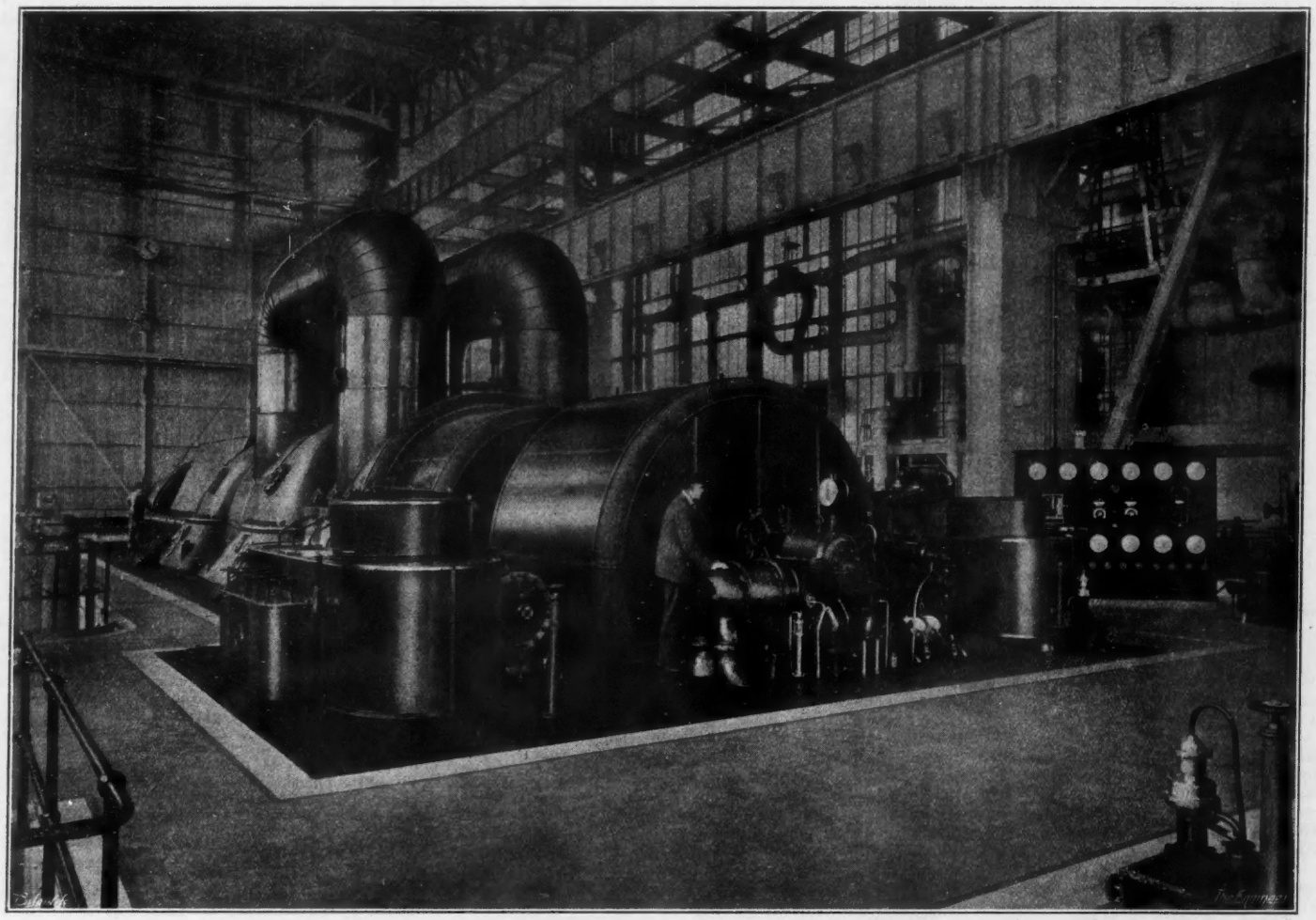
A NEW type of paint has been developed in America by M. T. Harvey, under the name of Harvel. Its base is the oil of the cashew nut, and it is said to be very suitable for painting concrete and ships' bottoms.

ELECTRICAL ENGINEERING IN 1933

(For description see opposite page.)



GENERAL VIEW OF B.T.H. 75,000-kW TURBO-ALTERNATOR SETS AT BARKING



STEAM END OF B.T.H. 75,000-kW TURBO-ALTERNATOR AT BARKING

Electrical Engineering in 1933.

No. I.

Introductory.

GRADUAL improvement experienced in various sections of the electrical industry during 1933 was accompanied by a rise in the utilised productive capacity, which now stands at about 60 per cent. There was a slight but definite decrease in the monthly unemployment returns, but with the completion of "grid" contracts the home demand for heavy electrical equipment now leaves much to be desired. Despite the 20 per cent. tariff foreign manufacturers managed to produce certain goods at sufficiently low cost to make importation practicable, although in some cases it was found more profitable to manufacture in England. Some thirty manufacturers of electrical apparatus are said to have adopted this policy, chiefly in the London area.

Compared with 1932 the imports of electrical goods and apparatus slightly decreased. For the eleven months ended November, 1933, their monetary value was £2,239,246, against £2,495,142 in 1932. Battery imports showed a remarkable decrease. Over the period mentioned they represented £16,232, compared with £86,226 in 1932 and £602,325 in 1931. On the other hand, there was an appreciable increase in the imports of electric carbons, which represented, in eleven months of the year, a sum of £135,452, the figure for 1932 being £86,245. Electrical machinery imports decreased from £748,282 in the eleven months of 1931, and £375,961 in 1932, to £206,109 in 1933. Owing chiefly to the depressed conditions of the primary purchasing countries, however, the export figures for the corresponding period of 1931, 1932, and 1933 were £4,004,271, £3,313,893 and £2,411,935, respectively. Although the exports of electrical goods and apparatus showed an increase over 1932, they did not attain the value of £6,951,032 for the corresponding eleven months of 1931. The figure for the eleven months of the past year was £6,022,721, and £5,301,209 for the same months of 1932. Wires and cables, telegraph and telephone apparatus, carbons, lighting bulbs and batteries, all improved their position slightly, the main falling off being in instruments and electric light fittings and accessories.

Power Stations

During the year the new Battersea power station, in which there are at present two 67,200 kW generating sets, was linked up with the grid. Work on the erection of the new Fulham station, with an initial capacity of 132,000 kW, of which we give a picture on page 14, made satisfactory progress. The 150,000 kW Dunston station of the North-Eastern Electricity Supply Company, the new Barking 150,000 kW station, the 25,000 kW Blackburn Meadows station of the Sheffield Corporation (illustrated in one of our Supplements), and a small station of the Borth and Ynyslas Electric Supply Company, were put into service during 1933. The foundation stone of Tir John North, the first of the projected two selected stations for South-West England and South Wales was laid by Sir Andrew Duncan at the beginning of May.

Generating Sets.

When the Metropolitan-Vickers Electrical Company completes the 105,000-kW turbo-generator set ordered in the early part of the year by the London Power Company for the new Battersea station, it will have acquired the distinction of having built a unit 40 per cent. larger than any other set made in England. The turbine will be a three-cylinder machine designed for 1500 r.p.m. with a double flow low-pressure cylinder, having a Metrovick duplex multi-exhaust in each flow. There will be two condenser units, each with a cooling surface of 45,000 square feet. Another interesting machine under construction in the Trafford Park works is a 24,000-kW, 3000 r.p.m. turbine designed for exceptional steam conditions, viz., 1763 lb. per square inch gauge and a temperature of 932 deg. Fah. continuously, or 968 deg. for short periods. The turbine will exhaust into an existing boiler range at a pressure of 384 lb. per square inch gauge, and at normal load the quantity of steam passing through the turbine will be about 300 tons per hour. The massive construction of the machine can be gauged by the fact that the thickness of the high-pressure flange will be 12in., while the bolts employed on this section of the machine will be 6in. in diameter. A contract for generating plant of 120,000-kW capacity for the new Fulham power station was also received by the Metropolitan-Vickers Electrical Company.

Official thermal efficiency figures for 1933 are not available, but analysis of the Electricity Commissioners' returns for 1932 show that the Clarence Dock power station of the Liverpool Corporation attained the record figure of 24·72, which was closely followed by the Deptford West station of the London Power Company with 24·55 per cent. The fuel consumption per unit generated at Clarence Dock in 1932 was 1·17 lb., which, with the exception of the figure for the Portishead station of the Bristol Corporation, which led all stations with a consumption of 1·15 lb. per kW-hour, was the lowest recorded. The Metropolitan-Vickers Electrical Company takes pride in the fact that it manufactured the plant at Clarence Dock and Portishead, and that during 1932 more than 85·9 per cent. of the units generated at Deptford West were produced by its machines.

Among the more important sets put into service by C. A. Parsons and Co., Ltd., were the second and third 50,000-kW units at the Dunston power station, a second machine of 36,000 kW capacity at Copenhagen, a 20,000-kW set at Cape Town, and a 15,625-kW set at Pretoria. The Dunston machines are notable by reason of the re-superheating of the steam to its initial temperature of 800 deg. Fah. during its passage through the turbines, while the Cape Town unit has the distinction of being the only generator outside this country to be worked at a pressure of 33,000 to 36,000 volts. The fact that a second machine of equal voltage and output has been ordered is a clear indication that it has given satisfaction. The receipt of this order brings the total number of 36,000-volt Parsons turbo-alternators in service or under construction to seven, with an aggregate output of nearly a quarter of a million kVA. Of these, an 18,750-kW, 36,000-volt machine was completed during the year for the Treforest station, while the construction of the two 30,000-kW units to generate at the same voltage in the new Swansea station was brought to an advanced stage. Besides the order for the second 20,000-kW high-voltage machine for Cape Town, one was received from the East Rand Proprietary Mines, Ltd., for a 20,000-kW unit to work at 22,000 volts.

Other orders were received for a second 20,000-kW unit for Calcutta, and for a fourth 20,000-kW unit for Durban. All these machines are to be of the single-cylinder type, running at 3000 revolutions per minute. An alternator of the same capacity and speed is under construction for the Dutch State Mines. Of the orders received from Holland, however, the most interesting was that for a switchgear testing unit to be used in the laboratories of the N.V. tot Keuring von Electrotechnische Materialen, at Arnhem. This machine is to have an output of 900,000 kVA at either 11,000, 6350, 5500, or 3200 volts, according to the external connections of the windings. It will be the largest plant of its kind to be installed in any independent testing laboratory. A still larger Parsons turbo-alternator for testing purposes is now in course of construction for Reyrolle and Co., Ltd. This machine, which will have a maximum capacity of 1,500,000 kVA at 3000 revolutions per minute, and at 22,000 volts or at several lower voltages, will be a duplicate of a machine already supplied by C. A. Parsons to the same firm, and its installation will provide A. Reyrolle and Co., Ltd., with by far the most powerful testing plant in the world.

Two 12,500-kW units at the Carville power station were reconstructed by C. A. Parsons in order to increase the frequency from 40 to 50 cycles. Orders for smaller machines, ranging between 4000 kW and 1000 kW capacity, were received for power stations in India, China, and Australia, while industrial turbo-generators, mostly of the geared "Uniplane" non-basement type, were ordered by a number of British and overseas manufacturing firms. These machines are generally arranged to pass out steam for heating or process work. They vary in size between 3000 kW and 100 kW, and several are to be provided with both alternating and direct-current generators. Research work at the Heaton Works led, among other things, to the production of hollow stainless steel turbine blades, which open up obvious possibilities to the turbine designer.

Both the B.T.H. three-cylinder, 75,000 kW turbo-alternators for the new Barking power station were completed and put into operation during 1933. The sets, which are shown on page 10, were manufactured partly at the B.T.H. Rugby works, and partly in the Trafford Park works of the Metro-Vick Company, and are the largest built in this country up to the present time. The normal pressure at the stop valve is 600 lb. gauge, and the maximum pressure 700 lb. Normally, the steam will be superheated at the stop valve to 800 deg. Fah., but the sets may be operated continuously at 850 deg. Fah. Steam is bled at four points on the turbine casing to heat the condensate up to 340 deg. Fah. at a load of 60,000 kW, when the normal vacuum is equivalent to 1in. of mercury absolute. The erection of the B.T.H. 30,000 kW turbo-alternator at the Ford Motor Company's works, Dagenham, is nearing completion. A 9000 kW machine of the same make was put into service at Bowater's Mersey paper mills. From this turbine, which is fed with steam at 300 lb. pressure and at a temperature of 650 deg. Fah., 170,000 lb. of steam at a pressure varying between 10 lb. and 20 lb. are extracted per hour for process work. A new type of double-flow, low-pressure cylinder for B.T.H. multi-cylinder turbines was developed for operating with a single condenser instead of two condensers, a design which considerably reduces the overall length of a generating unit. During the year two orders were secured for machines with this new type of low-pressure cylinder—a 22,500 kW, 3000 r.p.m. turbo-alternator for the Shanghai Power Company's Riverside power station, and a 25,000 kW, 3000 r.p.m. for the Schaebick power station of the Interbrabant Company, near Brussels. The Southern Railway also placed an order with the B.T.H. Company for a 12,500 kW turbo-alternator for its Wimbledon generating station.

The welded steel form of construction is being employed by the B.T.H. Company in the manufacture of turbines and condensers, particularly in connection with self-contained units. A 1250 kW extraction turbine being supplied to Peebles and Son, Ltd., for service at the Rishton paper mill, has a welded steel condenser shell, and a welded steel reducing gear case. Other B.T.H. machines on which welded steel will be employed extensively are two 3750 kW combined units, which are being supplied to the order of Nixon Forrest and Co., Ltd., for the Ahmedabad Electricity Company, Ltd. Each of these units will consist of a turbine driving the alternator, condensate extraction pump and circulating pumps through reduction gears. The cases for these gears, the oil tank, which forms a support for the reduction gear, and the condenser shells, will be composed of welded steel. A 50 kW, 10,000 r.p.m. geared turbine and D.C. generator of extremely light weight, was built to the order of Cammell Laird for the Admiralty. On the electrical side one of the most interesting jobs carried out at Rugby was the reconstruction of one of the 25,000 kW, 1500 r.p.m., 25-cycle alternators at the Stourport power station for 50-cycle operation, and for direct generation at 33,000 volts.

Two important hydro-electric installations with B.T.H. equipment were put into service during the year. In March the largest Government installation in India, namely, that at Uhl River, was officially opened and four B.T.H. alternators, totalling 53,300 kVA, are now in service. The new Tummel Power Station of the Grampian Power Company, which is nearing completion, will contain two B.T.H. alternators having a total capacity of 42,500 kVA.

The General Electric Company reports that overseas markets are providing a demand for oil and steam-engine-driven alternators. South Africa, Buenos Aires, Palestine, Barbados, New Zealand, Cyprus, Manchuria, Bombay, Madras, Macao, and Persia were among the parts to which such machines were supplied, or are to be supplied in the near future. An interesting control system was devised by the G.E.C. for the South African Iron and Steel Corporation, which purchases some of its power in bulk from the Pretoria Municipality, the remainder being generated in its own power station at Iscor. The scheme involves the control of the turbo-generator sets in the latter station, so that the power drawn from the Pretoria station is, as far as possible, constant, and is supplied at unity power factor, the whole of the apparatus being automatic in action.

(To be continued.)

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

MULTIPLE MARINE OIL ENGINES.

SIR,—Mr. Ricardo in his recent lecture to the Institution of Mechanical Engineers has put forward a case for a multiplicity of high-speed oil engines as the prime mover for a ship requiring about 5000 S.H.P. Might I venture to suggest that he has prejudiced his case by stating that the transmission of power to the propeller shaft should be by electric drive? On the contrary, it would seem to me that a suitable geared drive would give a considerable reduction in weight, space, and first cost, whilst an increase in efficiency of nearly 10 per cent. would also be obtained.

Mr. Ricardo refers to the excellent performance of the high-speed oil engines, installed in lorries and omnibuses. He omits, however, to refer to the excellent performance of some clutches, gear-boxes, and back axles on the road.

For marine service, does not drive to an extension of the propeller shaft by either spiral bevel or worm gear offer the possibility of a very neat and compact engine-room? A single main gear-box could conveniently have five high-speed engines ranged along each side, the engines naturally being placed athwartship.

The engines would be coupled to the main gear-box through suitable secondary gear-boxes, which would include double-acting clutches to give either forward or reverse drive. It would probably not be necessary to have more than one speed ratio for forward drive and one speed ratio for reverse drive.

Now, is it really true to say that the complication introduced by the clutches is intolerable? It seems rather that it would be quite possible to devise a system of mechanical control which would be much simpler than, and at least equally as reliable as, that required for the electric drive.

With the arrangement of geared drive described above,

two main gear-boxes could be conveniently arranged in tandem, so that some twenty engines could be coupled to the one propeller.

A. H. WARING.

Norton-on-Tees, January 1st.

"THE THIRD DIMENSION."

SIR,—The tragedy of the aeroplane "Apollo," taken with the steady increase in air casualties reported in the Press as more and more machines get into action, make one wonder whether we shall ever really solve the problem of flight, so as to render it a "safe" means of transport in the sense that land or sea travel is "safe." We have been developing aviation now for thirty years with every aid that modern science could give; we can perform aerobatics that, as Sir John Fisher once remarked, "beat the birds at their own game"; but we forget that the birds do not try what instinct tells them involves a needless risk, that is where we both win and loose; and in attempting flight as a sound commercial passenger-carrying business, evidence is beginning to accumulate that we are making little or no progress or are asking too much from the progress we have made.

To the engineer the suspension of a heavy aeroplane, with its complement of passengers in unstable equilibrium between the pull of gravity and the wind pressure controlled by the human factor, must logically involve risks that cannot apply to land or sea-borne vehicles. Are we not shutting our eyes to the obvious in this as in so many other directions, and in the mad rush of modern "progress," building up an edifice that is doomed to fall? To those who fly in the service of their country or for sport and adventure, the risk is part of the game, but one wonders if it is fair to encourage women and children to accept it, and particularly so long as petrol forms the stable fuel of such machines.

The true test, I feel—and notwithstanding the recent disaster on the French railways—is to ask oneself what might be the casualty rate if as many passenger aeroplanes took the air every day as trains leave the London termini, and I greatly fear the answer, if based on purely logical argument and available statistics, would destroy the rather premature boast of our "conquest of the air" entirely.

DUBIOUS.

January 1st.

STEEL TRADE REORGANISATION.

SIR,—I have read in your editorial columns with considerable interest the outspoken letter, which appears in your to-day's issue, from Mr. Stanley G. Newstead, dealing with a subject worthy of note, if not of extreme importance, to all engineers, to wit, reorganisation of the steel industry.

To my mind, as a mere layman, I cannot see how an improvement in plant efficiency, on the one hand, and the establishment of a better economic level generally on the other, can be obtained, as your correspondent suggests, by abolishing the Steel Association and entering instead on a period of unrestricted competition, till such times as the industry finds its own salvation.

If this ever happened, is it not safe to assume that one or two of the surviving companies, having obtained a virtual monopoly, would between themselves, untrammelled from bureaucratic control, keep prices of steel at artificially produced levels. In other words, the last state would be worse than the first.

GEOFFREY A. TIPPETT,
Oxford, December 29th. Member, Institute of Fuel.

THE CENTENARY OF THOMAS TELFORD.

SIR,—I have undertaken the task of preparing a new monograph on the great Scottish engineer, Thomas Telford, first President of the Institution of Civil Engineers, the centenary anniversary of whose death is next year. I would appeal for the co-operation of any of your readers who have, or who may know of the existence of, any original letters, papers, or other material relating to Telford or dealing directly or indirectly with him and his work. I would particularly like to be able to trace any private correspondence, since Telford's personal and social side and the intercourse with his friends of this most delightful of companions have remained almost wholly unrecorded.

In this connection I would be grateful, too, for references to any published memoirs, letters, or biographies which contain any references to Telford, though not directly dealing with him. ALEXANDER GIBB.

Queen Anne's Lodge, Westminster,
London, S.W.1, December 27th.

SIXTY YEARS AGO.

IN the review of the past year which we published in our issue of January 2nd, 1874, we gave first place to the progress that had been made in sanitary engineering. This new branch of engineering may be said to have been called into existence by a recent Act of Parliament under which the discharge of sewage into rivers was prohibited. Numerous processes for treating the raw sewage were devised with the double object of rendering the effluent innocuous and of recovering valuable manurial material from the residue. One of the principal of these processes was that known as the A.B.C., operated by the Native Guano Company. That company was treating sewage by this process at Bolton, Leeds, and Hastings, with, it was said, complete satisfaction. In the London area its operations had, however, met with opposition. It had established experimental plant at the Crossness southern outfall works of the Metropolitan drainage, and for three months treated an average sewage flow of nearly 12 million gallons a day. Technically, the process was reported to be a success, but commercially it was regarded by some as unsatisfactory. The Metropolitan Board of Works came to the conclusion that the process could not be operated with profit to the ratepayers, and uncompromisingly refused to allow the company to continue its experiments. It required the company to remove the whole of its plant, even to the foundations of the tanks, which had to be blown up by gunpowder. The company's experiment had cost it 7s. 6d. for every ton of sewage treated. It complained bitterly that the Board had taken advantage of the fact that it was the only local authority exempted from the prohibition against the discharge of raw sewage into rivers. Passing on to other branches of engineering we came to the construction of bridges. The Tay Bridge was then fast approaching completion, and one of a very similar type was shortly to be begun over the Forth. It is of interest to note that, not for the first time, we criticised the design of the Tay Bridge. On this occasion we commented upon the fact that the girders were of the lattice type, with intersecting diagonal bars in the web, and with vertical struts equal to about half the depth of the girder resting upon the intersections. The arrangement, we said, was not one to be recommended. In the section of our review devoted to marine engineering, we find it stated that marine engine builders as a body were dissatisfied with the existing type of high-pressure boiler. They were expensive, bulky, and subject to rapid deterioration, and could only be retained in use with safety by a progressive reduction of the pressure with their age. A boiler might begin its life with a pressure of 60 lb., which, year by year, would be reduced until it fell to half that amount. To maintain the power the expansion in the high-pressure cylinder would be reduced until the cylinder took steam for the full stroke. Thereafter, a direct connection between the boiler and the low-pressure cylinder would be made. There was, we asserted, no such thing known at sea as a boiler which would work for five or six years at its original pressure. In these circumstances, attention was being turned to the water-tube boiler. One notable experiment in that direction had been tried. The "Montana" had been fitted by Messrs. Palmer with water-tube boilers designed by Mr. John Jordan. These boilers consisted of 350 tubes, each 15in. in diameter by 15ft. long. The tubes were made of ⅜in. boiler plate, welded longitudinally. Superheaters were included in the design. After seventy hours' steaming, tube after tube began to give way at the weld. The boilers were, in fact, a total failure. Nevertheless, we expressed our faith in the water-tube boiler system, and anticipated that the experiments then being conducted by Messrs. Howard, of Bedford, and by others, would advance the problems involved far towards solution during the ensuing year.

Canadian Engineering News.

(By our Canadian Correspondent.)

Water Power and Mining.

THE steady growth of Canada's mining industry is creating an ever-increasing demand for electricity. This statement is qualified by two recent announcements, one to the effect that the Hollinger Consolidated Gold Mines, Ltd., had completed a contract with the Ontario Hydro-electric Power Commission for the purchase of power from the new Abitibi Canyon development; the other that the Northern Quebec Power Company had decided to extend its power transmission line from Noranda, a distance of 32 miles north into the mining properties in that district. While the agreement between the Ontario Commission and the Hollinger company only calls for an initial amount of 700 H.P., provision is made for increasing the demand to a maximum of 22,000 H.P. Not long ago the Ontario Commission announced the sale of a considerable block of power from the Abitibi Canyon development to the Canada Northern Power Corporation, which, in turn, will be sold to mining companies.

English Tin Plant.

The Chamber of Commerce of Sarnia, Ontario, announces that the Winton Steel Company, of England, will establish a plant in Sarnia for the manufacture of tin-plate and eventually black sheets. The firm will utilise part of the plant of the Dominion Alloy Steel Corporation for the present, and the announcement states that machinery is on the way.

The Caughnawaga Bridge, St. Lawrence River.

The Caughnawaga Bridge, on completion, will span the St. Lawrence River between Ville La Salle and Caughnawaga. It is situated 12 miles from Montreal, and, including the north and south viaducts, will have a length of 4471ft. The overall length of the structure, which includes the earth fill approaches on both sides of the river, will be 6070ft. Thirteen piers have been sunk to bed rock, eleven by the pneumatic caisson method, to support the steel superstructure, which will be 2920ft. long. The roadway will be 27ft. wide, and, in addition, the plans provide for a footway 4ft. in width for pedestrians. All the river piers, the south viaduct piers, and roadway slab, and the north viaduct piers, are now completed, and work on the superstructure of the bridge is proceeding rapidly. In completing the major portion of their part of the contract, A. Janin and Co., Ltd., of Montreal, have finished their task in approximately eight working months, a year ahead of schedule. Despite this noteworthy accomplishment, the construction of the piers, approaches, and understructure was carried out without a hitch of any kind, and a safety record was set, for there were no fatalities or major accidents, an unusual result in hazardous construction undertakings of this nature. The construction of the bridge in swift and deep water forced the contractor to exercise his ingenuity to the utmost in order that the piers could be safely and speedily erected. Another problem confronted the contractor, for unless the work was done during the open water period, he would be faced with the complications of the ice problem. In addition, the area assigned for the contractor's use was very small, and therefore it was necessary so to co-ordinate the work and the deliveries of materials that no storage would be necessary. An interesting feature of the construction was the use of a light structural steel system in place of reinforcing, which permitted the use of specially designed forms, and entirely eliminated false work. This combination permitted the construction of a 1250ft. concrete deck in twenty-eight working days.

Industry in the Maritime Provinces.

The Maritime Provinces are speeding up many industrial activities. The Nova Scotia steel industry has received two orders having a total value of over 2,000,000 dollars, consisting of steel rails for South Africa and for the Canadian National Railways. The first-named order has been completed, but the 50,000 tons in the latter order will keep the plants busy for the balance of the year. Coal production has expanded as a result of the increased demand from the steel companies. The output of the Cape Breton collieries of the Dominion Iron and Steel Corporation amounted to 349,000 tons in September, as against 297,000 tons in August, and 191,000 tons in September, 1932. The pulp and paper plants in this section of the Dominion have been operating to capacity. In one or two instances, output has substantially exceeded the anticipated maximum.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

PHENOL AND TAR ACIDS.

The British Standards Institution has just issued seven new specifications covering phenol and the whole range of the more generally used cresylic and carbolic acids. Certain of the specifications will be of some interest to pharmacists, and of first importance to the manufacturers of pharmaceuticals derived from phenol or cresol, their use ensuring the supply of regular quality from one consignment to another, and of tar acid fractions which are already commercially available. Makers of synthetic resins and the disinfectant manufacturers will, on the other hand, be concerned at one time or another with each of the whole series, and the same argument of routine commercial availability of uniform material will be sufficient to ensure the fullest use of the specifications by these two industries.

The explosives, soap, synthetic perfumery, leather, photographic chemicals, dyestuffs, paint, and brewing industries come readily to mind as immediately interested in most of the specifications under review, but in point of fact a much longer list could be compiled of manufacturers who will find one or other of them of first importance.

The specifications are completed by the inclusion of precisely defined methods of testing compliance or otherwise with each specification, the standard methods of the Standardisation of Tar Products Tests Committee having been specially reviewed and amplified for the particular purpose of these specifications.

These seven new specifications are numbered:

515—1933, Crude Carbolic Acids, 60's and 45's;
516—1933, Distilled Carbolic Acids, 60's and 45's;
517—1933, Cresylic Acid of High Orthocresol Content;
521—1933, Cresylic Acid (50/55 per cent. Metacresol);
522—1933, Orthocresol, Metacresol, and Paracresol;
523—1933, Phenol, and 524—1933, Refined Cresylic Acids.

STRUCTURAL STEEL FOR GIRDER BRIDGES.

153—1923, Addendum. This is an addendum sheet C.D. (PW) 907, for inclusion in the current issue of Part 3, Loads and Stresses of the B.S. Specification No. 153 for Girder Bridges.

The specification is being reviewed, and a revision of Parts 1 and 2, Materials and Workmanship, was issued early this year. The revision of Parts 3, 4, and 5, dealing respectively with Loads and Stresses, Details of Construction and Erection, which were originally issued in 1923, is proceeding, but has not yet been completed.

As important alterations to the permissible working stresses in Part 3 had been agreed upon, it was considered advisable to issue them without waiting for the completion of the revision in order that the advantages of the increases in the allowable working stresses might be available for work at present proceeding.

The essential alterations consist in the increase in the basis unit tensile stress from 8 to 9 tons per square inch, with a corresponding increase for the compression members. Recognition is also made of the increase in the strength of girders in which the compression flanges and webs are encased in concrete, the allowable permissible stress on both tension and compression flanges now being 10 tons per square inch.

The shear stress in web plates has been increased from 5 to 5½ tons per square inch, and whilst shear on shop rivets remains at 6 tons per square inch, bearing stresses have been increased from 12 to 15 tons per square inch.

Consequent upon these alterations, the permissible excess above the specified working stress in Clause 13 (combined stresses) is reduced to 15 per cent., and that in Clause 14 (erection stresses) to 20 per cent.

Copies of the Addendum Sheet C.D. (PW) 907 may be obtained gratis on receipt of a stamped addressed envelope by the Publications Department of the British Standards Institution, 28, Victoria-street, London, S.W.1.

Railway and Road Matters.

ONE of the L.M.S. Railway's Standard 4–4–0 (Class 2) passenger engines, No. 633, has been experimentally fitted with a "Dabeg" feed-water heater, and a second engine is to be similarly fitted in the near future. The apparatus is carried on the L.H. engine frame above the platform.

FOLLOWING its recent successful exhibition at Euston, where in three days over 33,000 people inspected the train, the "Royal Scot," which recently returned from its 11,000 miles tour of the North American Continent, is to be placed on exhibition early in the New Year at about fourteen of the principal English and Scottish centres on the L.M.S. Railway.

THE Ministry of Transport railway statistics for the month of September last show that, when compared with the corresponding period of 1932, there was an increase of 7·1 per cent. in the number of passenger journeys and of 6·1 per cent. in the receipts from passengers. The tonnage of freight rose by 6·3 per cent. and the freight traffic receipts by 4·6 per cent. The freight train-miles increased by 3·3 per cent.; the average train load from 117¾ tons to 121 tons; and the net ton-miles per engine-hour from 439¾ to 451.

THERE were only two train accidents last year in which passengers lost their lives; four were killed in the Raynes Park derailment on May 25th and one at Glengarnock on September 30th, when a load on a passing freight train struck a passenger train going in the opposite direction. In 1932 there was one fatal derailment and four passengers killed. The number of servants killed in train accidents was more numerous than usual. In contrast to the three killed in three accidents in 1932, there were nine killed in six accidents; in three accidents both the driver and fireman were killed.

THE accident at Hellifield, on December 19th, in which the driver and fireman of a freight train lost their lives, was inquired into on December 29th by Lieut.-Colonel Anderson. From the evidence given in public—the signalman in the Hellifield Goods Yard box gave his testimony in private—it appears that a goods train from Liverpool to Hellifield ran into the loop and came to a stand. The guard said he applied the brake on the van and the wagons were detached and shunted. A dense fog prevailed, and, through it, the signalman in the Goods Yard box saw something pass him, which proceeded along the down line, in the wrong direction, and collided with a goods train from Manchester to Carlisle. From this it is obvious that the loop points were not restored after the Liverpool train ran into the loop and the brake, by some means, ran back down the loop and escaped.

THE unusual term "Crocodile," which has been so much in evidence in connection with the French railway disaster, is applied to what, in the corresponding use on our own Great Western Railway, is known as the ramp. It is a wooden strip, laid in the "four-foot," upon which is placed a layer of copper, over which a metal brush, carried by the locomotive, passes, and so an electrical current is passed from a local battery near the distant signal through the copper and the metal brush to the locomotive. Should the signal be at "danger" a positive current is sent, and the whistle blown; if the signal is at "clear" a negative current passes, and the whistle is not opened. An official description supplied to the Cairo International Railway Congress stated that the upper face of the layer of copper is drilled with holes and paraffin poured into the cavity in order to prevent the formation of hoar frost or ice. Whilst not stating that such was the case, it is possible that at Lagny on the evening of December 23rd, the ramp was covered with sufficient frost to prevent the "danger" contact being made, and a false "clear" indication would thus be given. The Cairo Congress report also said that the French Eastern Railway, being well satisfied with the apparatus, did not feel called upon to undertake tests with devices which operate the brakes when a signal at "danger" has been passed. We would add that the Great Western of England uses a plunger instead of a fixed brush, and should the raising of the plunger, when going over the ramp, not be accompanied by current from the signal at "clear," the "danger" indication is given; in other words, the absence of current gives an alarm. Ice on the ramp would prevent the current flowing, and so the raising of the plunger will give a "danger" signal.

THE circular letter of November 18th, 1873, from the then President of the Board of Trade to all the railway companies, to which we referred in "Sixty Years Ago" on December 15th, could not have been the result, as the letter suggested, of a large number of serious accidents, as, compared with other years of that period, it was by no means an exceptional year. It is true that there was the Wigan disaster, but in the other cases there was one killed in each of eight accidents, and the average for the fourteen, excluding Wigan, was less than two. What undoubtedly contributed to Mr. Fortescue's circular was a letter written by Queen Victoria to Mr. Gladstone on October 3rd, 1873, in which Her Majesty, in characteristically vigorous style, drew the attention of the Cabinet to "the very alarming and serious state of the railways. Every day almost something occurs and everybody trembles for their friends and for everyone's life." The main inspiration of Mr. Fortescue's communication was, however, the issue of the first report by Captain Tyler that was a sequel to the Act of 1871. The Royal Commission on Railway Accidents came about eight months later, and, moreover, was not the result of Parliamentary or public pressure, but a concession to the then Earl de la Warr for the rejection of a Bill for the block system, interlocking, &c. The Royal Commission, by the way, drew attention to the great increase in traffic at that period, an increase from 169 million tons in 1871, to 200 millions in 1875. They said, further, "these figures, taken by themselves, do not convey an adequate impression of the effect of this increase in the working of the railways, for the largest increase was in the great centres of population, and in the manufacturing and mineral districts—that is, in places where the traffic was already great. In many such districts the traffic was more than doubled."

Notes and Memoranda.

WHILE relaying the Brandleite tunnel on the Berlin-Stuttgart line between the stations of Gehlberg and Oberlief, taking advantage of the even temperature in the interior of the tunnel, 30 m. (98ft. 4in.) rails have been welded together into four continuous lengths—two in each track—of 2640 m. each, or 8662ft. 6in., leaving no joint within a mile and a half.

THE *Monthly Review* of the Moscow Narodny Bomh has it that "the output of electric power during the first year of the operation of the Dnepr hydro-electric station was 385 million kilowatt-hours. By the end of the first year the output reached 1,400,000 kilowatt-hours per day." The latest reports in "Garcke" show that the Manchester Corporation supply, a coal-burning installation, produced 398 million units in the year, at a cost of 0·66d. per unit sold.

BY special methods of insulation, according to Mr. Warnes Govan, of Toronto, fire-safe homes of six good-sized rooms and bathroom, with front and back porches, have been built in Canada for 3000 dollars approximately. With outside temperatures dropping to as low as 40 deg. below zero, less than 50 dollars worth of coal is being used each winter to keep them thoroughly comfortable. At a cost of 1600 dollars equal comfort and safety could be provided in a similar four-room dwelling.

THE following are the conclusions contained in a paper on "Electric Arc Welding Under Water," presented by Messrs. N. S. Hibshman and C. D. Jensen to the American Welding Society recently:—(1) Welds of good quality may be made on low-carbon steel under water; (2) this method of welding may be found of use in experimental work where it is desired to limit the heat penetration from the weld or avoid distortion of the parent material from excessive heating or where it is desired to make a weld shielded from nitrogen and other gases present in the air; (3) cast iron is regarded as being as weldable in water as in air.

THE response of greenhouse crops to electric light, supplementing daylight, has been strikingly demonstrated in one of the greenhouses of the Utilities Research Commission of Chicago, devoted to horticultural studies. In several specific instances studied, a 15-watt lamp placed 4ft. from the bench and applied for a few hours each night was found effective in inducing early flowering and increased stem length. More recently it has been discovered that plants respond to certain portions of the spectrum, particularly those approaching the red end, much more favourably than to other portions, and that the blue-green portion actually serves to inhibit best growth.

A DESCRIPTION is given in the *Engineering News-Record* of the new 250-ton crane at the Puget Sound Navy Yard, U.S.A. It is of the fixed tower type, with a rotating jib. It will lift the full load at a radius of 115ft., or 30 tons at 180ft. to a height of over 100ft. With the test load of 700,000 lb. at 115ft. radius, the deflection at this point was 3¼in. The trusses, when reamed in a horizontal position at the time of shop pre-assembly, were given an upward camber of 6$\frac{1}{16}$in. at the extreme end of the cantilever, calculations showing that the remaining camber under dead load only would be 5·022in. A check after completion of erection showed a remaining upward camber at the extreme end under this condition of 5·00in. The tower structure, under no load, leaned backward ¼in., and with the full load of 250 gross tons at 115ft. radius, the leaning of the tower was forward and amounted to ¼in. With the maximum load on a single main trolley (about 350,000 lb. at 115ft. radius) the difference in the elevation of the two trusses caused by this excentric loading was ¼in.

SEVERAL investigators have studied the effect of high jacket temperature on the performance of liquid-cooled aircraft engines at sea level. To obtain data on the effect of changes in jacket temperature at various altitudes, preliminary tests have been made, by the U.S. Bureau of Standards, with a Curtiss D-12 engine in the altitude laboratory at the Bureau. The engine was operated at a constant speed of 2000 r.p.m. under conditions corresponding to sea level, 10,000ft., and 20,000ft. altitude. Under each condition, the jacket-water outlet temperature was varied from about 30 deg. to 95 deg. Cent. The results of these tests show that friction decreases and fuel economy increases at all altitudes as the jacket-water temperature is increased. At sea level and at low altitudes the power output decreases with increasing jacket-water temperature. However, at altitudes above about 9000ft. the power output improves as the jacket-water temperature is increased. A further study of the effect of cylinder-wall temperature on engine performance at altitude is desirable, not only for estimating the advantages of high-temperature liquid cooling, but also for evaluating the effect of cooling air temperature on the performance of air-cooled aircraft engines.

IN the course of a recent lecture before the South Wales Section of the Society of Chemical Industry, Mr. E. A. Rudge discussed the results of a recent examination of several cases of wet rot in greenheart, and in pitchpine, and showed that in every case the incipient stages of decay were accompanied by the infiltration of certain inorganic salts. He then developed a theory of decay based upon inorganic infiltration, and illustrated it with a number of specimens and analyses. It was pointed out that whatever might be the efficacy of creosoting against the attack of micro-organisms, that method of timber preservation had little effect in preventing the movement of inorganic salts under suitably moist conditions. Mr. Rudge introduced a very interesting case of decay, the specimen being the butt of a telegraph pole which had broken after twenty-two years' service. This had failed due to the formation of ring shakes which were close together at the outside of the pole, and were progressively wider apart towards the centre. Since the ash content of the shake was 0·5 per cent., whilst that of the wood between the shakes was about 0·16 per cent., this example was considered not only as a confirmation of the Inorganic Infiltration theory, but also indicated that something akin to periodic precipitation determined the zones at which incipient weakness developed.

Miscellanea.

THE receipts of the Suez Canal increased during the year from £6,240,000 to £6,677,000.

THE height record for aeroplanes carrying a load of a ton has been broken by the French aviator Bourdin, who reached 30,185ft.

THE Bulawayo Municipality proposes to put in a new 4000-kW set in its power-house at a cost of £30,000, and a new boiler at a cost of £6000.

THE Ava Bridge, near Sagaing, over the Irrawaddy River, was formally opened on January 2nd, 1934, by the Governor of Burma, Sir Hugh Stephenson.

THE Lhassa palace of the Dalai Lama, the ruler of Tibet, is to be equipped with a 220-cell storage battery by the Chloride Electrical Storage Company, Ltd.

THE Government of India has decided to lend assistance to the manufacture of alcohol from molasses to be mixed in the proportion of 20 per cent. with petrol for power purposes.

THE Finnish Railway Board has placed an order for 12,000 tons of rails. Of this total, 7000 tons are stated to have been placed in Great Britain, 3000 tons in France, and 2000 tons in Belgium.

STREET refuge posts, made of rubber and carrying a red light, which will bend on being run over and afterwards spring back into their normal position, have been successfully tried out at Leicester.

IT is reported from Belgrade that deposits of mercury ore have recently been discovered in Slovenia, and that French, English, and Italian groups are already interested in the possibilities of these deposits.

PLANS and estimates for the Mettur hydro-electric project are expected to reach the Government of Madras before March next. Provision will probably be made in next year's Budget for the development of the project.

SOME fifty-three Italian railway workers passed through Baghdad early in December on their way to Persia, where they are to assist in the construction of the Persian railways. It is understood that these men are the vanguard of 500 Italians, possibly 1000, who are being recruited to accelerate the carrying out of the Persian Government's project of a railway linking North and South Persia.

IT is reported that President Roosevelt has instructed Army Engineers to restudy, on the basis of providing a 30ft. channel, the proposed plan for constructing a waterway across the Florida Peninsula. It has been learned that the President felt that a 35ft. channel would be too expensive, and that there was no real necessity for such a depth at this time. Few ships of a size that would require a 35ft. channel would utilise the canal.

THE last caisson for the Trans-Bay Bridge at San Francisco was safely landed within 6in. of its designed position. This caisson is to form the foundation of the east main tower of the double suspension bridge west of Goat Island, being the pier located nearest the island, and is 74½ft. by 127ft. in horizontal dimensions. The water depth at the site is 105ft. from low water level to mud, and the caisson is to go down to rock at 170ft. below low water.

A LARGE stainless steel order has, according to the *Iron Age*, been placed with Republic Steel Corporation, Ohio. It is to be used in the fabrication of the Firestone insulated stainless steel beer barrel. The barrel is of double-walled construction with a lining of Enduro stainless steel insulated by dead air space from the outer shell, which is built of plain steel. The use of stainless steel for the lining of the barrel obviates the necessity of pitching and eliminates cooperage.

ACCORDING to the *Iron and Coal Trades Review*, the Dutch railway authorities propose a thorough modernisation and development of the whole network of the railways in the Amsterdam district. The railway embankments are to be raised and new railway bridges built, to enable the large number of level crossings, which are a serious hindrance to traffic, to be reduced. A railway skirting Amsterdam is to be built with funds provided by the railway company, the State and the City of Amsterdam. Several large contracts will be placed shortly.

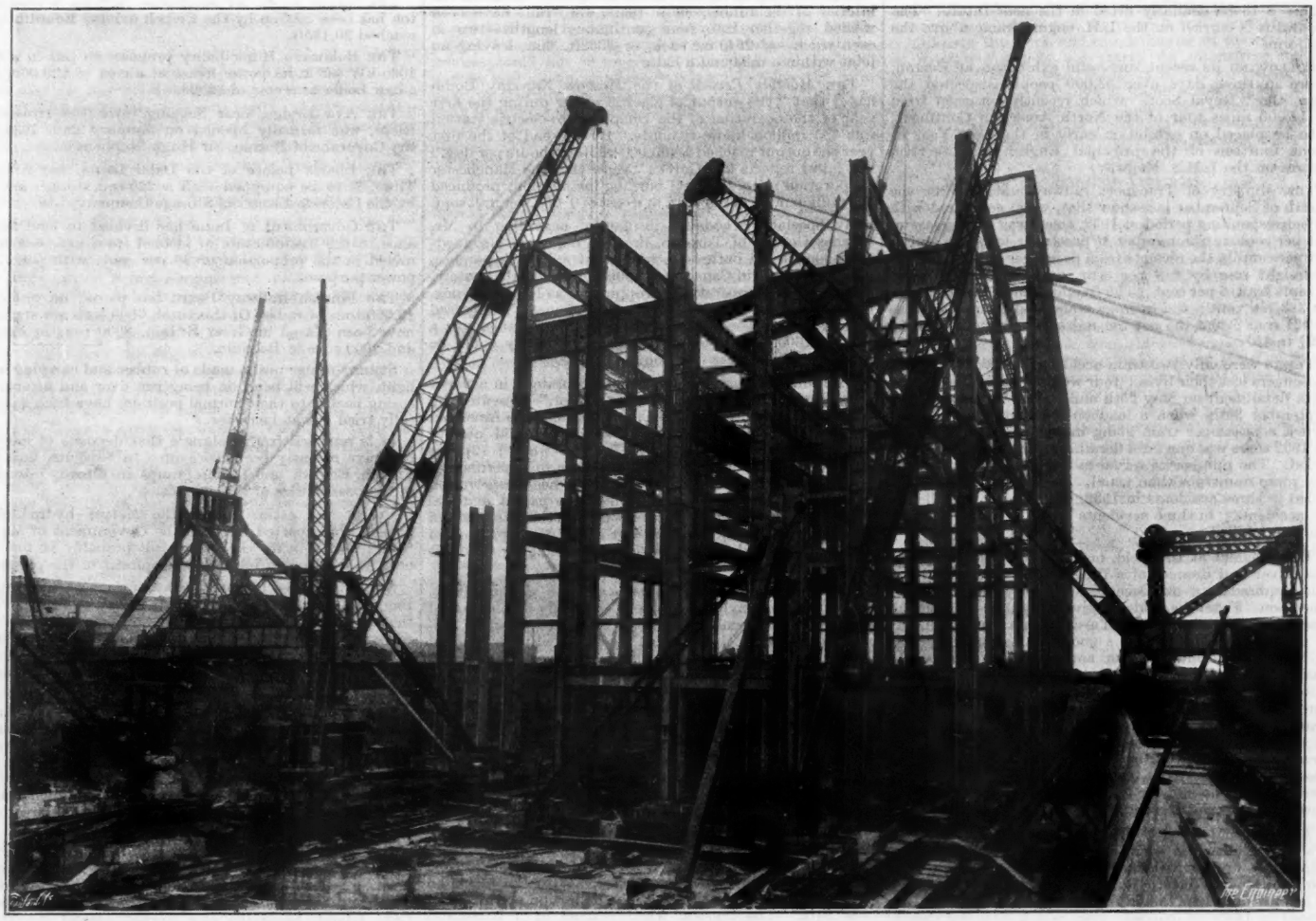
THE total output of pig iron in Russia during the first ten months of the current year amounted to 5,821,700 metric tons. This represents an increase of more than 14 per cent. over the corresponding period in 1932. The production of steel during the first ten months was 5,525,300 metric tons—an increase of more than 10 per cent. over the corresponding period of the preceding year. Coal output has increased by some 15 per cent. during the same period of this year, the output for the first ten months being 58,544,700 metric tons. In the last year before the war (1913) the total coal output was only 28,777,000 tons.

THE Dominion Bureau of Statistics estimate of the total value of the mineral production in Canada in 1933 is 198,253,000 dollars, compared with 182,682,000 dollars for 1932, an increase of 8·5 per cent. The total for 1933 does not include the gold premium for Canadian funds, computed at 23,378,000 dollars. The value of the metals mined was 124,382,000 dollars, an increase of 20 per cent. on last year, when the value was 103,495,500 dollars. The output of fuel, including coal and petroleum, was 47,315,000 dollars, or 3·5 per cent. lower, while that of non-metals, except fuel, but including asbestos, feldspar, and gypsum, increased by 28 per cent. to 9,898,000 dollars.

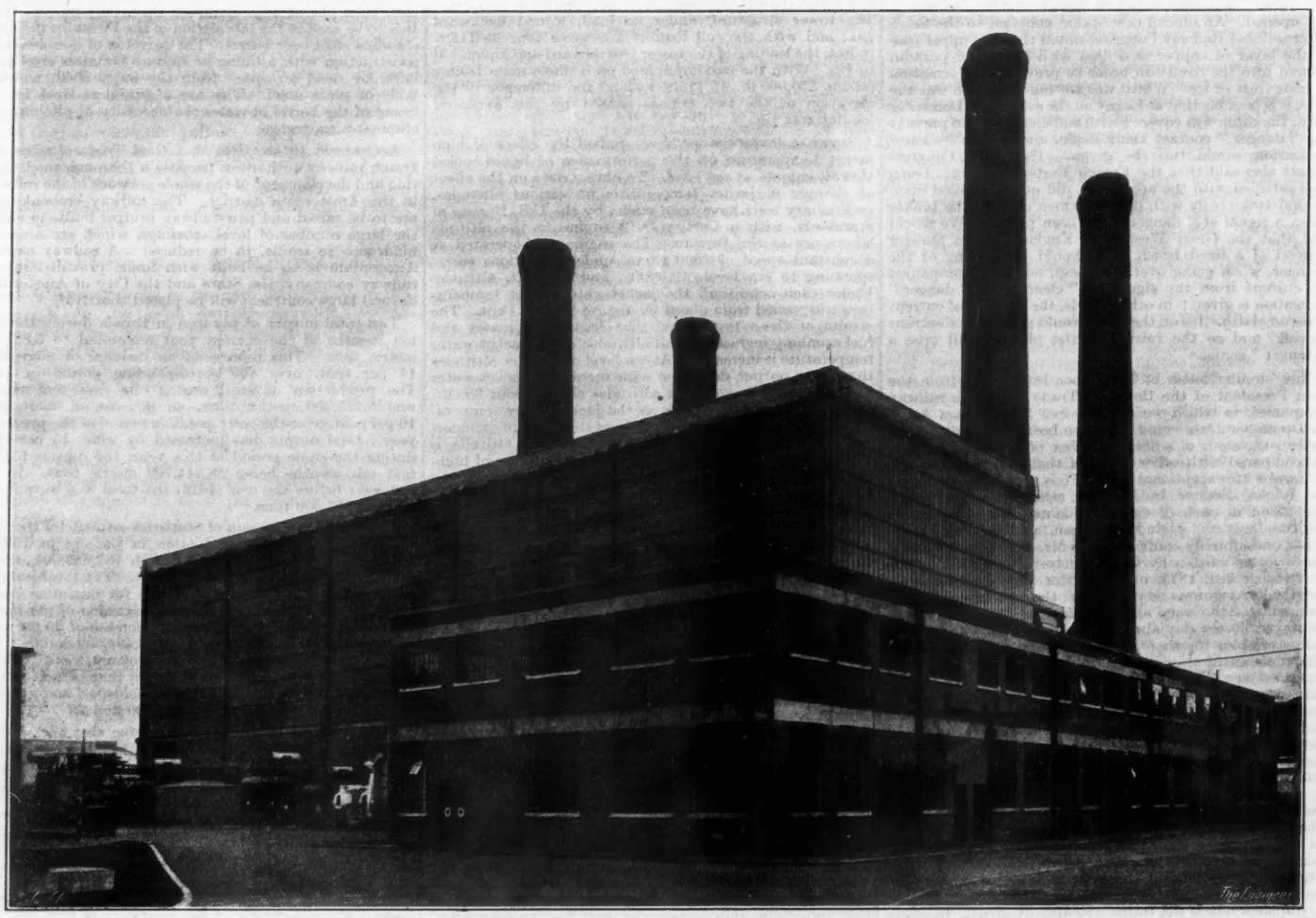
IT is reported in *Indian Engineering* that the work of reconstructing the Jumna road and rail bridge at Delhi has been practically completed, and that the bridge is likely to be opened within six weeks. The work consisted in replacing the seventy-year old spans by new girders suitable for modern loads. The new spans, generally similar in outline to the up-line girders, have been designed to carry a single-line railway track with the roadway beneath, and are suitable for 28-ton railway axle loads. The total weight of steelwork in the twelve spans is 5700 tons, and the estimated cost of the renewal Rs. 23 lakhs. The concreting of the roadways is now the only work still left unfinished.

ELECTRICAL ENGINEERING IN 1933

(*For description see page* 11.)



THE FULHAM POWER STATION UNDER CONSTRUCTION



THE NEW BARKING POWER STATION

The Engineer

JANUARY 5, 1934.

VOL. CLVII. No. 4069

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A Retrospect.

1933 may be described, not inaptly, as the first year of industrial convalescence. It was a remarkably interesting year. After many months of acute depression, and a heart made sick by deferred hope, a turn for the better took place. Early in the summer it became clear that orders which for a long time had been only in the air were beginning to settle, and when September arrived there remained little doubt that an improvement had begun. It cannot yet be safely said that "no more bulletins will be issued." The patient still is lacking in strength, and some unforeseen mishap or folly might cause a grave relapse. But, assuming that the doctors leave recovery to take place by natural courses, assuming that there is no ill-timed labour dispute, that the Government does not disturb the position by unwanted legislation, and that our relations with foreign countries continue to be friendly, there is no reason why the promise of last year should not ripen in this. These may be large assumptions. Labour, we know, is anxious to secure shorter hours for the same pay; the Government is always being pressed by some party or another to "do something"; and the conditions of international trade are far from being as stable as could be desired. The risks must be admitted. Yet there are those qualified to express an opinion who hold that the progress of Great Britain towards recovery is so good that a financial cataclysm in a foreign country would not now seriously affect it. Moreover, there are indications that not Great Britain alone, but the whole world, is rising from the depression. We sincerely trust it may be so. Our own prosperity will be fictitious and unenduring if it is not accompanied by the upward progress of other nations. We want them to be prosperous so that they may buy from us, and we can further that prosperity by buying from them. It should be unnecessary in these days to remind people that trade is essentially a reciprocal activity; yet some writers and speakers appear to believe in the possibility of Great Britain selling to foreign nations, but never buying from them! Even with the help of the huge volume of "invisible exports" which Great Britain enjoys in normal years, that is impossible. It would be a species of perpetual motion which is economically unthinkable. The value of imports may be, in the case of Great Britain, a more exact indication of the state of trade, than the value of visible exports.

The American Experiment.

Of the national events of the year, none was more interesting than the "Blue Eagle" campaign in the United States. Under the National Industrial Recovery Act, President Roosevelt was vested with autocratic powers to put the industries of America in order. He insisted upon each of them setting up a board, whose duty it was to prepare codes fixing hours of labour, rates of pay and prices. The hours in all cases were to be lower than those in general use, and the pay was to be on a generous scale. He believed that by this means the figures for unemployment, which had reached a colossal total, could be reduced materially in a few months, and that business would rapidly reach something like 75 per cent. of capacity. His object has not been attained. The campaign was seized upon by labour as an opportunity for increasing its influence. The "open shop" which has characterised nearly all American factories, was attacked. The trades unions sought to secure control of working conditions, and the employers rose in arms. There was continuous friction, organised labour demanding representation on code administrations, and the employers opposing that concession. Ultimately, General Hugh S. Johnson, National Recovery Administrator, refused to grant the demand, but there is a chance that Labour may get in through a new form of administration, which is under discussion. It seems, however, that it has given up, for the time being, all hopes of securing the thirty-hour week. The latest report is that no less than 1200 codes have been submitted to the N.R.A., but only 150 or so have been approved.

On top of these industrial difficulties, the financial position grew worse and worse, and was left in a state of uncertainty at the end of the year. It was, and still is, a very remarkable one. Owing to a number of causes which cannot be examined in this short review, the purchasing value of the dollar appreciated to a surprising extent. In other words, prices fell, and with them the money which agriculturists and manufacturers received for their products. The consequence was that, owing to reduced incomes, they could not pay their debts. The whole financial system was thereby upset, and the banking system—a far more fragile affair in the United States than in Europe—gave way, bringing further disaster upon the people. It has been Mr. Roosevelt's object in the past nine months to restore prices, but success still evades him. In April the gold standard was abandoned with the hope that prices would rise and enable producers and purchasers to pay their debts. That hope has not been realised. On the other hand, the exodus of capital and a fall in public funds caused further embarrassment. We must not pursue the matter further, but it will be obvious to all, even from this thumbnail sketch, that such vast prosperity as America enjoyed not long before the collapse may lead to courses which carry with them the elements of financial disaster. When Great Britain is accused—as she so often is—of maintaining a stodgy and inflexible financial system, it is well to remember that whatever its defects may be, that system has a factor of safety which is lacking in other systems, and which proves invaluable in times of stress.

Anxieties.

The British recovery was in pleasant contrast not only with the conditions in America, but on the Continent of Europe. Since January the number of unemployed had diminished by nearly 700,000 when December ended, and the financial position had so greatly improved that a surplus at the end of the financial year was assured. Despite this encouraging change in the industrial and business outlook, there were two or three factors which gave rise to not a little anxiety and a great deal of literature. Towards the end of the year the industrial competition of Japan on foreign, and even on the home market, became pronounced. That was one of the disturbing factors. The other was the injury being done to the trade of our mercantile marine by foreign shipping subsidies. To these subsidies we might retaliate by also subsidising our shipping lines. But that is a course to which this country is opposed in principle, and it is hoped that some other plan for meeting State-aided competition will be discovered. We venture to suggest that the shipping lines themselves can do much to improve the position. A change is coming over sea-borne traffic. The old tramp is doomed. It is no longer large enough or fast enough. Around our coast thousands of ships are still laid up. The best place for many of them is the bottom of the Atlantic or the breaker's yard. They are out of date. To put them on the market where they may be snapped up by foreign owners for a mere song is folly. The only wise course is to destroy them and fill their places with new vessels, which, at any rate on merits, will compete with the subsidised foreigner. We shall be glad to see this individualistic effort made before the State—which means the pockets of all the people—finds the money to support a conflict which, in the end, will prove disastrous to all parties.

Japan.

A debate in the House of Commons in December brought to a head the protests against Japanese competition which had been heard for some months. Owing to the depreciation of its currency, low wages, and long hours, combined with technology equal to that of the West, the Island Kingdom of the East finds little difficulty in underselling Great Britain in foreign markets, and has such a large price margin in hand that it can defy our import duties. This has been freely called "unfair" competition. As between two nations that term is a misnomer. In this country we have elected to do certain things; to work relatively short hours for relatively high wages; to give expensive social services; to tax manufacturers highly; to rate them excessively; to spend vast sums on unemployment insurance and relief works. Japan has not laid all these burdens on her industries, and, particularly, she is content to work long hours for low wages. There is no indication that she finds that a hardship. We do not hear of her machine-men grumbling because they earn no more than thirty shillings in a sixty-hour week. There is no indication that her people are sweated; that "the faces of the poor are being ground"; that the young are ill-nourished; or that the industrial classes as a whole are miserable. There is as far as we know no parallel between industrial Japan of to-day and industrial England at the time of the Chartists. She does what she is doing because the East is the East. It can not only tolerate, but enjoy conditions which might be obnoxious in the West. Can we say, justly, that it is unfair of her to take advantage of these natural conditions? The unfairness, if any exists, is, largely, of our own making. We have encouraged, we have helped, Japan to "Westernise" herself. We have taught her how and given her the means to do under easy Eastern conditions what we have to do under more burdensome Western conditions. We, for our own advantage at the time, have sold her the sword with which she may slay us. We have also, for our own gratification, added to the cost of living and lengthened the gamut of our necessities.

In these circumstances it is better to consider how we can carry on the fight than to charge the enemy with unfair practices. One course, the popular one in these days, is to ask the Government to "do something about it," though it is not at all clear that the Government can do anything, or that anything it could do would be as effective as what the manufacturers and merchants may do for themselves. One thing, however, there is which the State may do. That is refrain from all manner of legislation which may lay new or increased burdens on industry. If, by a reverse process, it could see its way to reduce some of the burdens which lie upon manufacturing industries, well and good, but at any rate nothing that will increase them—as, for example, a statutory working day and minimum wage—should have a moment's consideration. The Government may also manipulate tariffs and it may endeavour to secure Imperial co-operation for the general welfare of the Dominions and the Mother Country. But when it has exhausted all its resources, the fact will undoubtedly remain that as long as the equivalent cost of living in the East is far less than in Great Britain, competition of a very severe order through the industrialisation of the East must be met. It is probable that it will correct itself to a certain extent in the future, for a westernised Japan will, by degrees, develop western standards of living. In the meantime, we shall continue to look to Imperial trading agreements as the best means of preserving our overseas markets at a level which will enable us to obtain our over-sea necessities.

Quality *v.* Price.

Not far removed from this question is the problem of quality and price, which, during the year, was brought to an acute stage by correspond-

ence between the British Chamber of Commerce in Buenos Aires and the British Standards Institution. The Chamber averred that the price of British engineering goods in South America is too high, and that the standards of quality are above those of foreign manufacturers. The retort is that British goods sell on quality and that to lower standards would be retrogressive. There is, we admit with pleasure, no manner of doubt that quality is an important asset in British products. But we cannot close our ears to the continual statement from observers of foreign markets that a large proportion of local purchasers is quite satisfied with a lower standard if it can be had at a lower price. If, by salesmanship, we can force our more expensive products upon the market, well and good; but if not, it is manifest folly to maintain a standard which defeats itself.

To find an issue out of this difficulty is very far from easy. Many, if not all our standards, have been drawn up with an eye to home conditions. A number of them, for example, specify dimensions and other qualities which are designed to prevent danger to life and limb. In countries where life is less sacrosanct, or where fools are tolerated more gladly and allowed to take their own risks, these precautions—which are generally costly—are deemed unnecessary. Again, even where life is not jeopardised, we often stress materials less highly than do other nations. Consequently, the foreign products being made of lighter scantlings, are not only cheaper, but—an important factor—can be transported more cheaply. Finally, our conservative system of rating and notation may give an advantage to the foreign competitor, who appears to be selling more for the same money than we sell; the rating of air compressors, which, only by degrees, is being put on an international basis, is a case in point.

To meet these difficult conditions it has been suggested that two standards should be specified for machinery, just as there are different grades for materials. There are objections to that course, but since the alternative is to leave the market to foreigners, or to those home manufacturers who snap their fingers at standards, it cannot be dismissed without the fullest consideration. It must ever be kept in mind that if we cannot sell our standard products on a certain market, it is useless to make them for that market. Either, then, we must surrender the market or surrender the standard. If any standards are an embarrassment to us rather than a help and convenience, the sooner they are revised the better.

This, however, must be said. No one will willingly lower the British standards, or British qualities, or British prices, and, therefore, it is imperative that the evidence of their retarding effect should be examined with the greatest thoroughness and put beyond all question before any new step is taken. May we express the hope that the matter, having been raised, it will not, as on former occasions, be allowed to drop without full investigation.

Science in Parliament.

During the year efforts which had been exerted for many preceding months to secure better representation of the views of scientists in Parliament resulted in the definite formation of a Parliamentary Science Committee. This body had been adumbrated by the British Science Guild and the Association of Scientific Workers, and it only required the encouragement given by Sir Frederick Gowland Hopkins at the Leicester meeting of the British Association to bring it into actual existence. It is now supported by several learned societies, amongst which are numbered the Institution of Mechanical Engineers, the Institution of Naval Architects, the Institute of Metals, and the Society of Engineers. It is the intention of the Committee to promote discussions in both Houses on scientific matters which have national and economic bearings; to arrange for the delivery of scientific lectures before Parliamentary Committees; to consider Bills which have a scientific aspect; and last, but not least, to insist upon the due representation of science on Departmental and other Committees. We have put last the item which we believe to be the primary cause of the movement. It is alleged that technical and scientific matters are entrusted by Parliament to Committees which have not the necessary knowledge for the proper handling of them. It may be doubted if, in fact, the Committees and Commissions are hampered or their work illdone by reason of this alleged lack. Parliamentary Committees, and especially Commissions, have the power of calling expert witnesses, and there is little reason to suppose that they are not in a position to obtain all the scientific direction which they may need. How far the other activities of the new Committee may be welcomed by and profitable to Parliament remains to be seen. One of the aspirations is, no doubt, that scientists may be able to squeeze more money out of the Chancellor of the Exchequer for research. As, however, his decisions are arrived at through the advice of the Department of Scientific and Industrial Research, which is in a position to give complete documentation on all national and international aspects of scientific research, it is difficult to see that the new body can have more than a psychological effect, and to that, we suspect, few Chancellors are subject. Hence, whilst the actions of the Parliamentary Science Committee are still more or less in the melting pot, it would, we suggest, be vain to expect that it will cause any revolution in the attitude of Parliament towards science. In as far as actual expenditure on research is concerned, we suspect that Parliament, even under a Government which is not untouched with Socialism, will continue in the view that industries should help themselves, and that it must not be expected to find money for researches, save when, and not always then, they deal with fundamental problems.

Prospects.

The year opens with good prospects. The ball is at the feet of the manufacturers and traders. Success will depend more upon their personal efforts than on anything the Government can do for them. For many months there have been fewer developments in mechanical engineering in this country than could be wished. Lack of money to carry out experiments and, in the absence of purchasers, lack of encouragement to proceed with them have delayed the progress of new inventions. Manufacturers have been endeavouring to make what profit they could out of well-established "lines." But the seeds of invention have only been asleep, and in the warmth of industrial revival they should awake. We expect to see more progress in this year than in last, and we trust sincerely that more encouragement will be given to British inventors and less to foreigners than in the past. We need not repeat familiar arguments. It is enough to recall that every licence taken out to manufacture under a foreign patent means some loss of prestige to British and some gain to foreign engineering. If our engineers—and particularly directors who may not be engineers—desire to make a good resolution, let it be "British Inventions First." Only when the supply of British inventions fails should foreign licences be taken out. We know that that is a counsel of perfection; we know that it cannot be wholly attained; but we know also that the natural practical inventiveness of our people will bloom more brightly in the light of greater encouragement, and that the greater the number of British inventions adopted the more prolific will inventors become.

On the commercial side, no less than on the technical, the year will call for exceptional efforts. Some gambling on prospects may be essential. Propaganda and wise advertising must be carried on, even when money is low in the pocket, and the personal attention of the principals of firms to potential markets must not be neglected. South America will not be forgotten, but we suggest to manufacturers that the opportunities for reciprocal trade with Canada require intensive development. Too much of it still crosses the border; more of it should cross the Atlantic.

With these concluding words we commend 1934 to our engineering industries, in the firm belief that with courage and enterprise they will lift themselves far out of the greatest depression in modern history.

Shipbuilding & Marine Engineering in 1933

No. I.

THE long-awaited and hoped-for revival in shipbuilding and marine engineering, of which at one time there seemed to be a definite promise, was only partially realised, and 1933, taken as a whole, must be looked upon as probably the worst year which the industry has experienced in living memory. At many large yards few or no launches took place, and for the greater part of the year but a few per cent. of the available building berths were employed. Towards the end of the twelve months, however, there was a steady stream of new orders, mostly for motor liners for the Australian and New Zealand trade, which, together with the naval orders allotted and those about to be placed by the Admiralty with private shipbuilding yards, will go far to ensure a better state of affairs in the industry during the coming year. It will need, however, a further succession of orders if the industry and the many ancillary industries connected with it are to be rehabilitated on anything like a normal scale. Although it is recognised that there are many ships due for replacement, the past few years of deep depression and unbridled foreign subsidising of shipping alike on inter-Imperial and world trading routes, has precluded British shipping lines from raising in the usual way the necessary capital required for new construction. The Chamber of Shipping and other owners' associations, towards the end of last year, demanded that something be done nationally to re-establish world trading conditions in a way which

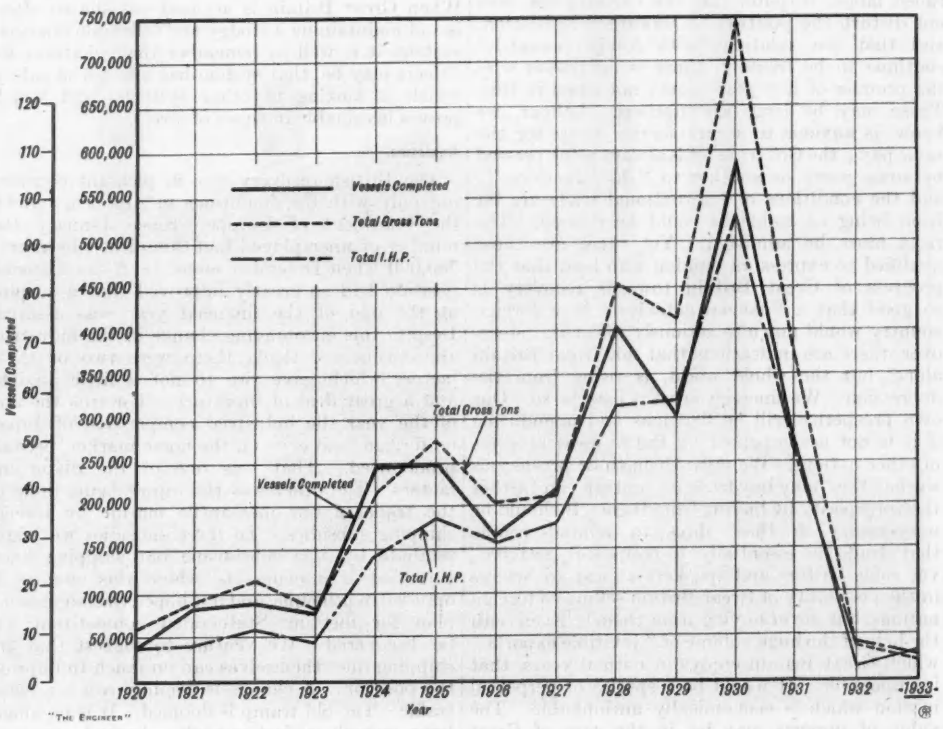


FIG. 1—BRITISH MOTOR SHIP AND MARINE OIL ENGINE OUTPUTS 1920—1933

will be favourable to the development of British shipping, the tonnage of which is already below our national and Empire requirements.

It seems likely that, in consequence of this and other representations, the Government will make some endeavour to encourage British shipping. If it can be restored to its old position, the technology of shipbuilding will be found ready to respond to any advances which may be called for. At the present time, the prices of materials are at their lowest, and the technical progress made alike in hull and machinery design are such that a highly efficient ship can be designed and built to meet any required trading conditions.

a conference of tank experimenters took place in Holland under the chairmanship of Mr. John de Meo, and in the coming summer an international meeting in connection with tank work is to be held in London by the Institution of Naval Architects.

Some Outputs of 1933.

The returns which we have received from the principal shipbuilding yards clearly indicate the restricted volume of work. One of the largest Clyde outputs was that of Lithgow's, Ltd., of Port Glasgow, at which yard five steamers were launched, aggregating 23,040 gross tons. Four of these ships are of the 5000-ton cargo class for J. and C. Harrison, Ltd., of London. Another large output was that of Swan, Hunter and Wigham Richardson, Ltd., which firm launched four British merchant ships and two small vessels for foreign account, aggregating 11,221 tons. At Belfast, Workman Clark (1928), Ltd., launched two passenger and cargo motor ships, each of 7000 gross tons, which are equipped with 5800 I.H.P. Sulzer oil engines, constructed by the builders. On the Tees, the Furness Shipbuilding Company, Ltd., launched two 4900-ton motor cargo ships, in which Doxford oil engines were installed. The firm also completed an 890-ton caisson gate for the Southampton King George V. Dock. At Glasgow, Harland and Wolff, Ltd., of Belfast, Glasgow, and the Wallsend works of the Parsons Marine Steam Turbine Company, Ltd., a total of 72,000 S.H.P. of marine geared turbines was constructed for naval and mercantile work, and mechanical gearing of 4000 S.H.P. was constructed in addition to that associated with the horse-power given for the geared turbine machinery. The company also cut gearing aggregating 103,000 S.H.P. for its licencees. During the year a large amount of gearing was cut by the Fairfield Shipbuilding and Engineering Company, Ltd., which also successfully specialised in the manufacture of steel and wooden furniture.

Turning to reciprocating steam engines, we have to record an output of eleven sets of machinery, aggregating 18,720 I.H.P., by David Rowan and Co., Ltd., of Glasgow, and six sets aggregating 6945 I.H.P. by the North-Eastern Marine Engineering Company, Ltd. This company also supplied superheaters for 168 boilers, representing about 170,000 I.H.P. Many of these superheaters were for conversion jobs. The Wallsend Slipway and Engineering Company, Ltd., constructed 128 oil-burning installations for marine and land work, and built six Woolnough water-tube boilers for locomotives. A considerable amount of repair work was carried out at all centres, a noteworthy return in this respect being that of Cammell, Laird and Co., Ltd., of Birkenhead, which dealt with 180 ships of over half a million gross tons, besides completing the cruiser "Achilles" and several small ships and railway boats.

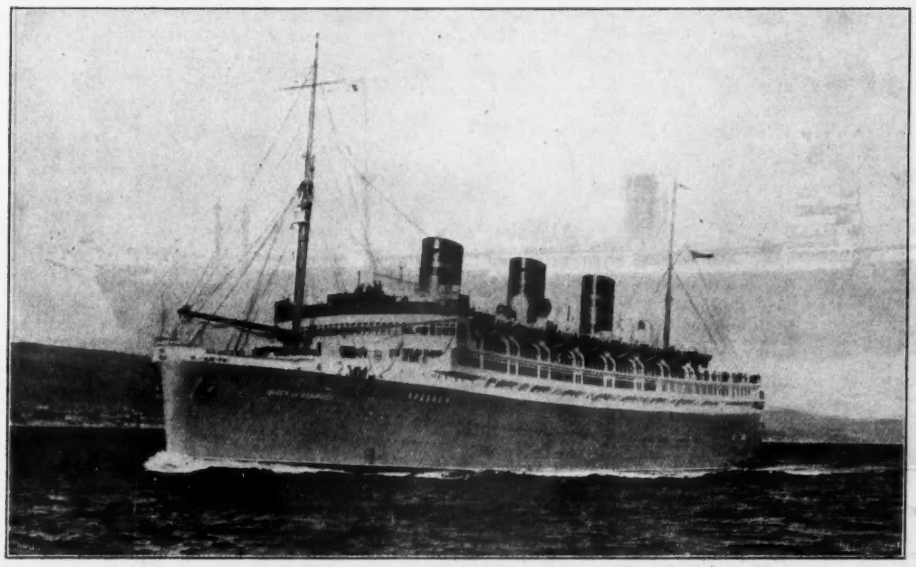


FIG. 2—THE FURNESS WITHY TURBO-ELECTRIC LINER "QUEEN OF BERMUDA"

Any review of the present position calls for some reference to the work of National Shipbuilders Security, Ltd., in connection with shipbuilding rationalisation, which was admirably outlined in an address given by Mr. F. C. Pyman, of William Gray and Co., Ltd., in West Hartlepool, on October 30th. Mr. Pyman pointed out that whereas in 1930 there were 684 berths, 43 had now fallen into disuse, and a further 116 had been purchased by National Shipbuilders Security, Ltd., making a total reduction of 159, or some 23 per cent. in building capacity. About half the available berths were normally engaged in the building of cargo vessels, and they have been cut down by some 30 per cent., whilst the liner and naval construction berths have been reduced by about 7 per cent. The rationalisation has, as far as possible, been carried out equitably between the different shipbuilding centres, and although some municipal authorities have protested at the closing of yards and the reservation of the sites for other industries, there is no doubt that the general feeling throughout the country is that the shipbuilders are tackling this difficult problem in a courageous and wise manner and that the work can be safely left in their hands.

On the more academic side of naval architecture, progress was recorded in the co-ordination of technical effort with a view to dealing more effectively with the problems of ship propulsion. During the summer

Large British Liners.

Scarcely a month passed in 1933 without some reference being made to the possibility of work being restarted on the 73,000-ton Cunard liner "No. 534," now on the stocks at John Brown's Clydebank yard. The aerial view of the ship on her berth with the 15,000-ton Canadian Pacific liner "Minnedosa," moored nearby, which appears in one of to-day's Supplements, shows clearly her large size. Throughout the year the task of the builders was confined to the preservation of the hull structure and the preparation of such parts of the ship's equipment as will be necessary immediately work is resumed. Great satisfaction was felt at the decision of the Government—recorded in our issue of December 22nd—to furnish the necessary financial assistance to complete the ship, now that an amalgamation of North Atlantic interests between the Cunard and White Star lines has practically been effected. The proposals of the Government must be awaited before it is known when work will be restarted and the launching date fixed, and whether a sister ship will be built. When these matters are settled, we presume that account will be taken of the advances in design made since the plans of the ship were first considered about five years ago, and that as far as possible the hull and machinery equipment will be brought into line with the latest practice.

In 1933, as in the previous year, the Canadian Pacific liner the "Empress of Britain" did excellent

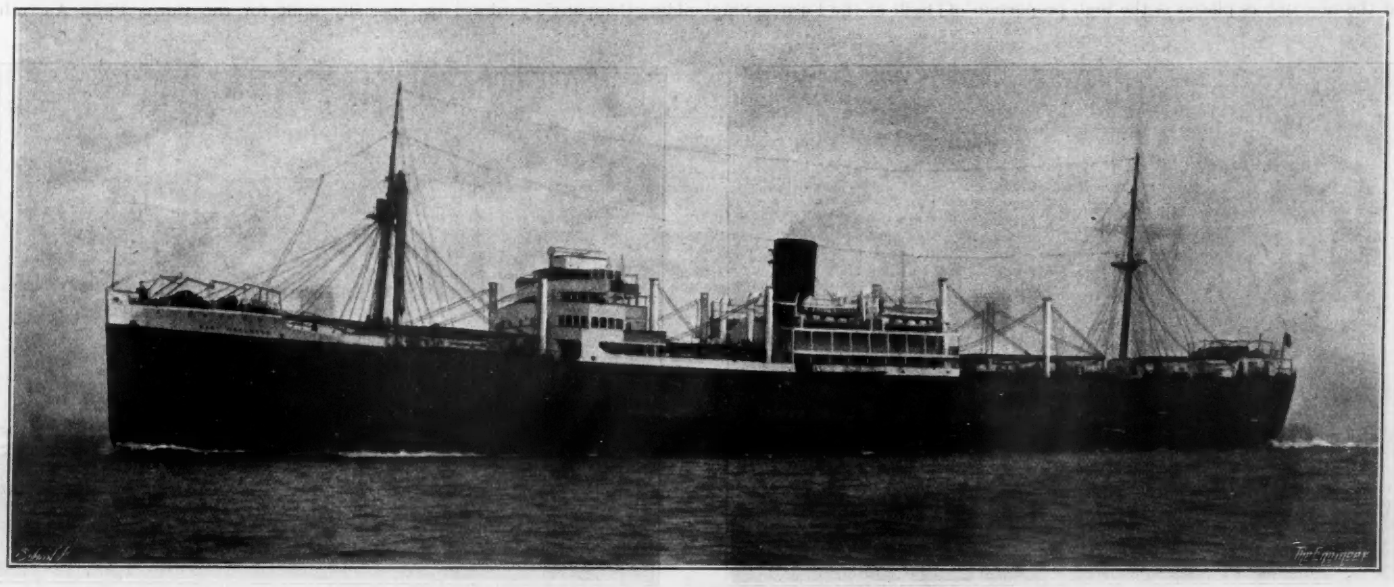


FIG. 3—THE DOMINION COMMONWEALTH MOTOR LINER "PORT CHALMERS"

London, only launched two small steamers, both for Indian service, and some small craft in London. It is satisfactory to record, however, that at the end of the year this firm, which has for many years past held a leading position in shipbuilding and marine engineering, had on its books orders aggregating approximately 62,500 gross tons and 133,200 I.H.P. These represent large refrigerated cargo motor vessels and tankers, and new steam machinery for the Royal Mail liners "Asturias" and "Alcantara." Although the firm's marine oil engine output of 1933 was restricted, the works delivered fifteen oil engines for the Iraq pipe line, rail-car engines, and industrial engines for oxygen manufacture, and the Bank of England power station. At

work, both on her North Atlantic and cruising services. In August last she established a new record by completing the voyage from Father Point to Cherbourg Breakwater in 4 days 7 h. 32 min., giving an average speed of 24·93 knots for the voyage, or 26 min. less than her 1932 record. A point of technical interest with regard to this liner is the fact that during the past year she was fitted with her spare propellers, which were modified in their blade sections in a manner agreed between the builders, John Brown and Co., Ltd., the makers, the Manganese Bronze and Brass Company, Ltd., and Mr. John Johnson, chief engineer of steamship services, Canadian Pacific Railway Company. We are able to state that whereas with the first propellers erosion took place.

that trouble has now been definitely eliminated, with smoother running and an appreciable gain in the ship's speed. The result attained is all the more satisfactory in view of the serious erosion trouble which has often been associated with the high-power propellers of fast liners.

Another large liner which was commissioned during the year was the Furness Withy New York–Bermuda liner "Queen of Bermuda," illustrated in Fig. 2. The ship and her propelling machinery were fully described in THE ENGINEER of February 24th and the two following issues. She was built by Vickers-Armstrongs, Ltd., and has a length of 579ft. 6in., with a measurement of 22,500 gross tons, and is propelled by a quadruple screw arrangement of turbo-electric machinery, designed and supplied by Fraser and Chalmers Engineering Works and the General Electric Company, Ltd. The ship has eight oil-fired 400 lb. pressure Babcock boilers, and her service speed is about 19¼ knots, with a trial speed of 19¾ knots. During the past season she has operated in conjunction with the "Monarch of Bermuda" in a manner, we are informed, entirely satisfactory to her owners and her builders.

Shortly before the end of the year Vickers-Armstrongs received orders to construct two large passenger liners, one for the Orient Line to Australia and the other for the P. and O. Company. Both of these ships will be propelled by geared turbine machinery taking steam from water-tube boilers.

Some Cargo Liners.

An outstanding feature of the vessels completed, and the new orders placed is the high proportion of motor passenger and cargo liners, many of them specially designed for the carriage of refrigerated cargo. The graphs we reproduce in Fig. 1 show clearly the rise and fall in the output of motor ships and marine oil engines over the period 1920 to 1933. It will be seen that the low level which was reached last year is practically equal to the output at the beginning of the development. The output is now on the increase, and next year a very different story will have to be told. In 1933 six ships totalling about 26,500 gross tons, with an aggregate of nearly 24,850 I.H.P., were completed. That output compares with only three ships for the previous year, which, however, were larger, and totalled 40,726 gross tons, with 48,300 I.H.P. of machinery. The largest motor vessel of the year was the "Port Chalmers," illustrated in Fig. 3. She was built by Swan, Hunter and Wigham Richardson, Ltd., for the Australian–New Zealand service of the Commonwealth and Dominion Line. Her length is 486ft. 6in., with a beam of 64ft. 3in., and a dead weight carrying capacity of 11,610 tons, her measurement being about 7500 gross tons. The propelling machinery, which was constructed by the associated company of Barclay, Curle and Co., Ltd., at the North British Engine Works, was fitted on board at Wallsend. There are two opposed-piston two-stroke Barclay-Curle-Doxford type engines, each driving its own scavenge pump. The total output of the two sets is 8500 S.H.P. The engines have four cylinders, with a bore of 640 mm. and a combined stroke of 2480 mm. Electric welding has been largely used on the oil bunkers and auxiliary machinery seatings, &c. The auxiliary oil engine driven generator sets are by Allens, of Bedford. Another feature of the ship is the large amount of insulated cargo space and the provision of the latest type of Hall carbon-dioxide refrigerating machinery, brine grids, and fans for supplying CO_2 gas to the holds. The whole of the deck auxiliaries and the steering gear are electrically-operated, Laurence Scott winches and a Clarke Chapman windlass and capstan being provided. The trials were very successful, the designed speed of 15½ knots being easily reached.

Two other interesting motor ships of the year are the "Devon City" and the "Houston City." The first—see Fig. 4—was recently completed. They were built at the Furness Shipbuilding Company's yard at Haverton Hill-on-Tees and engined by William Doxford and Co., Ltd. The "Devon City" and her sister, which are owned by Sir William Reardon Smith and Sons, of Cardiff, have a length of 440ft., with a beam of 56ft., and a measurement of 4920 gross tons. They are equipped with a single Doxford four-cylinder oil engine with cylinders of 600 mm. bore with a combined stroke of 2320, designed to develop 3200 B.H.P. at 95 r.p.m. The engine frame is of special welded steel construction and there is a lever-driven scavenge pump. Coupled to the same drive are the sea water, distilled water, and lubricating oil pump, thus making the engine self-contained in service. The consumption is about 0·36 lb. per S.H.P. for which up-to-date loading appliances are used. The engine of the latest B. and W. six-cylinder two-stroke double-acting crosshead type, with a designed output of 4000 I.H.P., gives a service speed of about 14 knots. The engine builders also supplied three 100-kW generator sets, and all the machinery was installed by the builders at Dundee. The ship is fitted with the owners' special design of streamlined semi-balanced rudder. A very successful maiden voyage has been made.

On the Clyde, Barclay, Curle and Co., Ltd., completed the passenger and cargo motor ship "Malaita," which is illustrated in one of to-day's Supplements. She was engined by John G. Kincaid and Co., Ltd., of Greenock, with a Harland-B. and W. single-acting two-stroke engine, designed to develop 1740 B.H.P. at 110 r.p.m. The eight cylinders have a bore of 500 mm. and a stroke of 900 mm., and the design is such that a 20 per cent. increase in output can be continuously maintained if required at any time. The "Malaita" was specially built for the Burns Philp Australia-Pacific Islands service and has a length of 325ft., a beam of 47ft., and a service speed of about 12 knots, with a measurement of 3310 gross tons. The measured mile trials, which were carried out at Skelmorlie in October last, showed a good margin of speed and power with a fuel consumption of 0·348 lb. per S.H.P. hour for all purposes and 0·32 lb. for the main engine alone.

Another motor ship of the year completed on the Clyde is the "Yochow," which was built and engined by Scott's Shipbuilding and Engineering Company, Ltd., of Greenock, for the China Navigation Company. She is a 3000 gross ton passenger and cargo vessel and is propelled by a single-acting five-cylinder Scott

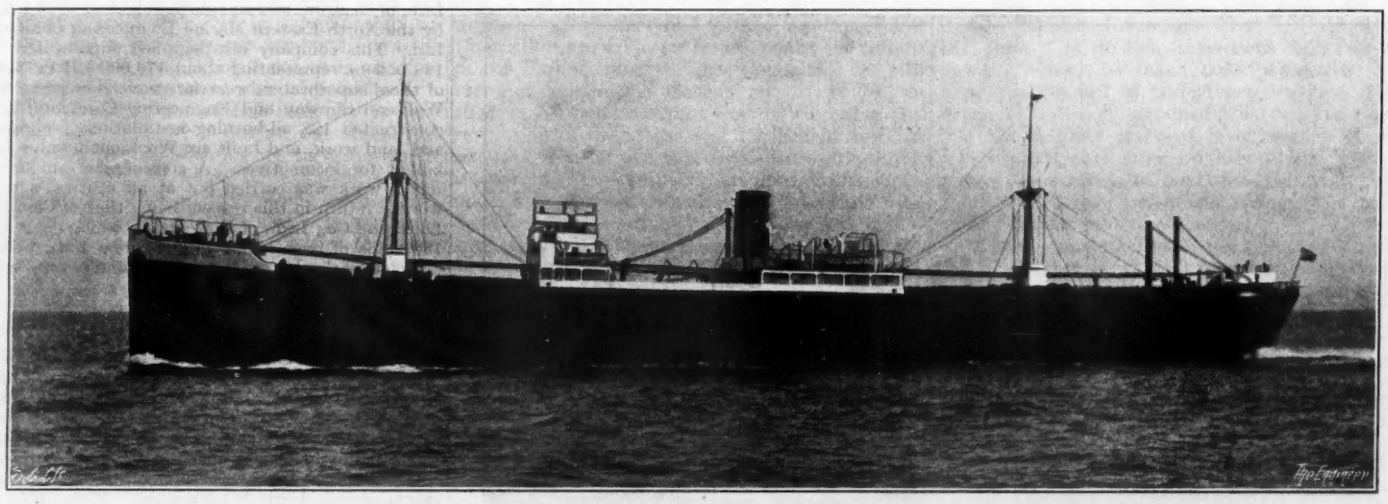


FIG. 4—THE REARDON SMITH MOTOR CARGO LINER "DEVON CITY"

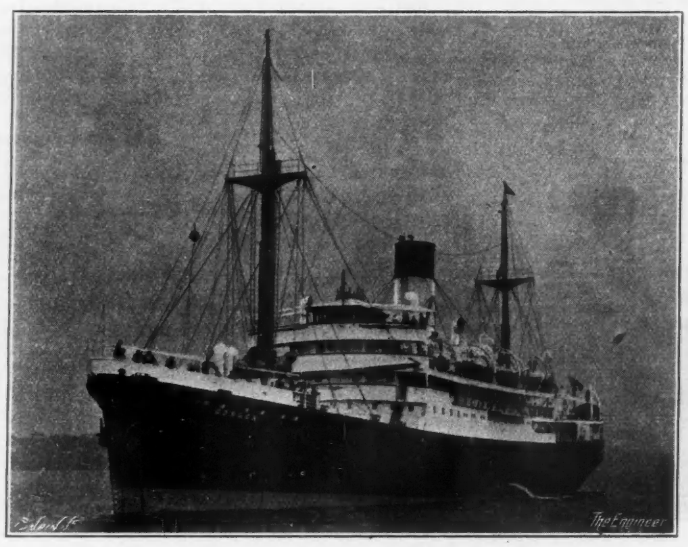


FIG. 5—THE BLUE FUNNEL MOTOR LINER "GORGON"

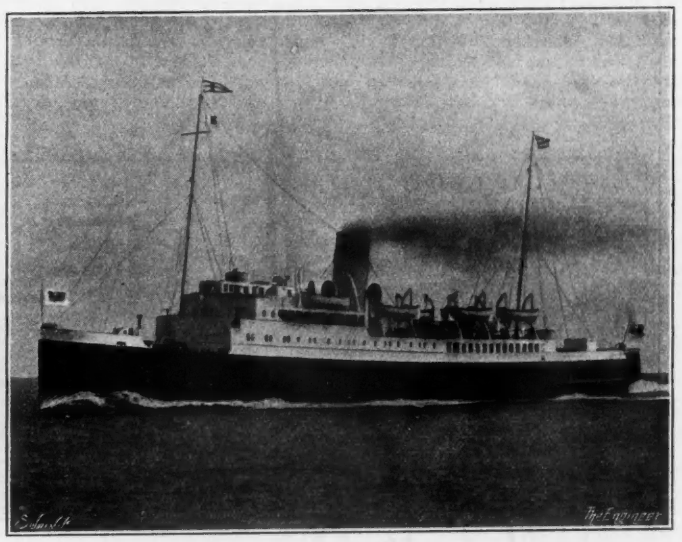


FIG. 6—THE CROSS-CHANNEL STEAMER "BRIGHTON"

oil engine. The cylinders have a 22in. bore with a 36in. stroke, and the rated service output is 1250 B.H.P. at 116 r.p.m., but an output of about 1560 B.H.P. can be obtained at 125 r.p.m. The design follows that of the earlier 27in. by 45in. Scott oil engine, but a number of new features have been introduced which simplify the engine while maintaining reliability of working and ease of operation. The engine drives its own scavenge and some auxiliary pumps. A Cochran exhaust gas boiler is fitted and a vortex silencer is placed within the ship's funnel.

A new hull development was Sir Joseph Isherwood's "Arcform" design, which was incorporated in three cargo steamers. During the year the

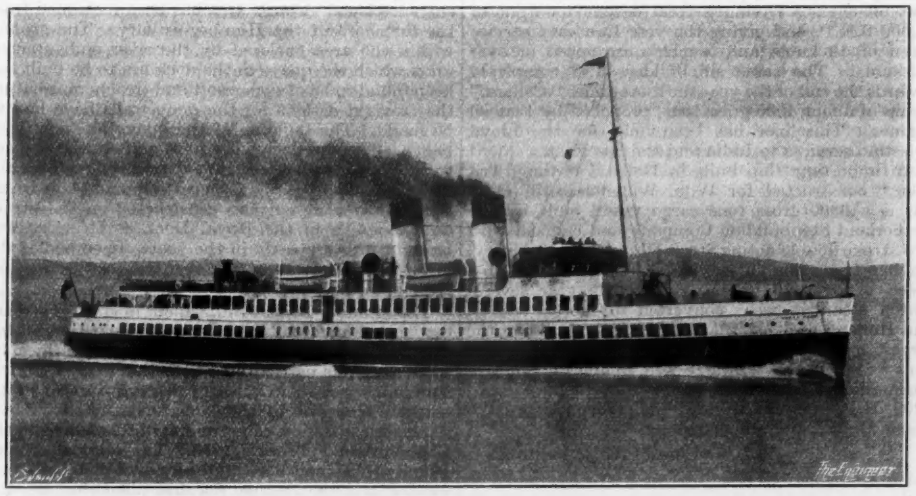


FIG. 7—THE CLYDE PASSENGER STEAMER "QUEEN MARY"

"Arcform," a 360ft. cargo steamer, was launched by Short Brothers, of Sunderland, and similar ships are under construction on the Tees and the Clyde.

River Estuary and Cross-Channel Steamers.

In Fig. 7 we illustrate the new Clyde passenger steamer "Queen Mary," built by William Denny and Brothers, Ltd., of Dumbarton, for Williamson-Buchanan, Ltd., of Glasgow, which was placed in service in May last. She has the widest beam of any of the Clyde steamers, her dimensions being 250ft. long, 35ft. broad, with a depth of 10ft. 7in. to the main deck. The accommodation is arranged for first and second-class passengers. Triple-screw machinery, with the propellers running at 800 r.p.m., is used, the H.P. turbine being arranged on the centre shaft and an L.P. turbine on each wing shaft. The astern turbines are fitted on the L.P. turbine shafts, so that the ship manœuvres as an ordinary twin-screw vessel. Saturated steam is provided by a 100 lb. pressure double-ended coal-fired Scotch boiler fitted with Neil's rocking grates and working on the closed stokehold system with forced draught.

Another Denny-built boat is the Southern Railway Company's Newhaven-Dieppe steamer "Brighton," which entered the company's service during the year and is designed to carry 570 first, 680 second, and 200 third-class passengers and can be used either for day or night service. A view of the ship is reproduced in Fig. 6. She has a length of 306ft. with an extreme beam of 38ft. 6in. and is the largest of the fleet of six vessels. She is propelled by a twin-screw arrangement of Parsons geared turbines, which work with saturated steam generated by four 250 lb. Yarrow type boilers, burning oil fuel, with an open stokehold balanced system of forced draught with air preheaters.

During the year Messrs. Denny also built a 260ft., 39ft. beam, 1445 gross ton cross-channel steamer, the "Brittany," for the Channel Island-France daylight service of the Southern Railway Company. She is designed to carry about 850 passengers. Her propelling machinery is of the Parsons single-reducton geared type, and saturated steam is supplied by one Yarrow and one single-ended Scotch boiler. Shortly before the end of the year the L.M.S. Larne-Stranraer 400ft. steamer "Princess Maud" was launched at Dumbarton. The propelling machinery of this ship is of interest, in that coal-fired Babcock and Wilcox boilers with Erith-Roe mechanical stokers are to be fitted. A similar boiler plant will be installed in the "Great Western," a passenger and cattle boat built by Cammell Laird and Co., Ltd., at Birkenhead for the G.W.R. Fishguard-Wexford service and launched on November 21st. Other small ships completed at Birkenhead during the year included two steamers for Mersey ferry service and a small motor ship, the "Southern Cross," for the Melanesian Mission.

Dredging Plant and Harbour Vessels.

Although the building of dredgers and harbour vessels shared to some extent the general depression, some ships of this class were built and commissioned during the year. On the Clyde, Ferguson Bros. (Port-Glasgow), Ltd., completed a twin-screw sludge steamer, the "Mancunium," which was built to the order of the Manchester Rivers Department. She has a length of 246ft., with a breadth of 38ft. 3in., and carries four large sludge tanks with a total capacity of 38,000 cubic feet. Twin-screw triple-expansion propelling machinery with modern auxiliaries and easily controlled loading and emptying valves for the tanks are provided. At Renfrew, Lobnitz and Co., Ltd., built only a small non-propelled oil tank, but shortly before the end of the year obtained an order for a large alluvial gold dredger for service in the valleys of the river Pek, on the Yugoslav-Roumanian border. At the Renfrew yard of Wm. Simons and Co., Ltd., there was launched early in December a large steam-driven cutter suction dredger of the firm's patented radial design. A special feature of this type of machine is that the hull is held stationary on three spuds, while the disintegrating and suction mechanism is traversed to and fro across the desired width of cut. The forward spuds are furnished with rams which enable the dredger to be moved forward for the successive cuts. The vessel was built to the order of the Chinese Trading Commission under the direction of Sir J. H. Biles and Co., of Westminster. It will be employed in keeping a clear berth for the Nanking train ferry in China. At Scotstoun the Blythswood Shipbuilding Company, Ltd., built the "Foremost Prince," a twin-screw bucket hopper dredger constructed to the designs of and for the service of the James Towage and Transport Company, Ltd., of London. The dredger was engined by Aitchison Blair and Co., Ltd., of Clydebank.

In our issue of August 11th we described a Ruston-Bucyrus 8 cubic yard dipper dredger built by R. and W. Hawthorn, Leslie and Co., Ltd., and engined by the Bucyrus Erie Company, of America, for service at the port of Le Havre.

Coastal Vessels, Tugs and Smaller Craft.

With the formation of a Coastal Trade Development Council early in 1933 there was during last year a welcome revival of coastal shipping and some specially designed coastal boats were built. The "British Coast," a 1000-ton motor ship, built for Coast Lines, Ltd., was completed by Henry Robb, Ltd., of Leith, and engined with Atlas-Polar machinery. A sister ship was also ordered from the same firm, while other coastal motor craft were built on the Clyde and in Ayrshire and engined with Polar and with British Kromhout machinery. A noteworthy vessel is the oil-electric tug "Lectro," built by Henry Robb, Ltd., for the Shell-Mex-B.P. oil barge service of the Union Lighterage Company, Ltd. The oil-electric propelling machinery was jointly supplied by the British Thomson-Houston Company, Ltd., of Rugby, and Mirrless, Bickerton and Day, Ltd., of Hazel Grove, Stockport. The tug, which was described in our issue of October 20th, has given an excellent account of herself in service. Another electric tug is the "Acklam Cross," built by Hall, Russell and Co., Ltd., of Aberdeen, for Robinson and Crossthwaite, Ltd., of Middlesbrough. She is propelled by twin-screw Brotherhood-Ricardo engines driving G.E.C. generators which supply current to the main propulsion motor. This boat was described in THE ENGINEER of September 8th. A Thames motor tug completed early in the year is the Atlas-Polar-engined tug "John Wilson," which was briefly described in our issue of January 20th, 1933. During the year a large number of barges were constructed for canal and river service by Richard Dunston, Ltd. of Thorne, near Doncaster, Henry Scarr, Ltd., o Hessle, near Hull, and by Charles Hill and Sons, Ltd., of Bristol, among which may be mentioned the "Severn" motor propelled trading barges constructed by the last-named firm. Among outstanding motor yachts of the year we may recall the "Trenora," designed and built by John I. Thornycroft and Co., Ltd., at Southampton, for Mr. Gerald E. Stanley. This fine vessel was fully described and illustrated in THE ENGINEER of August 4th.

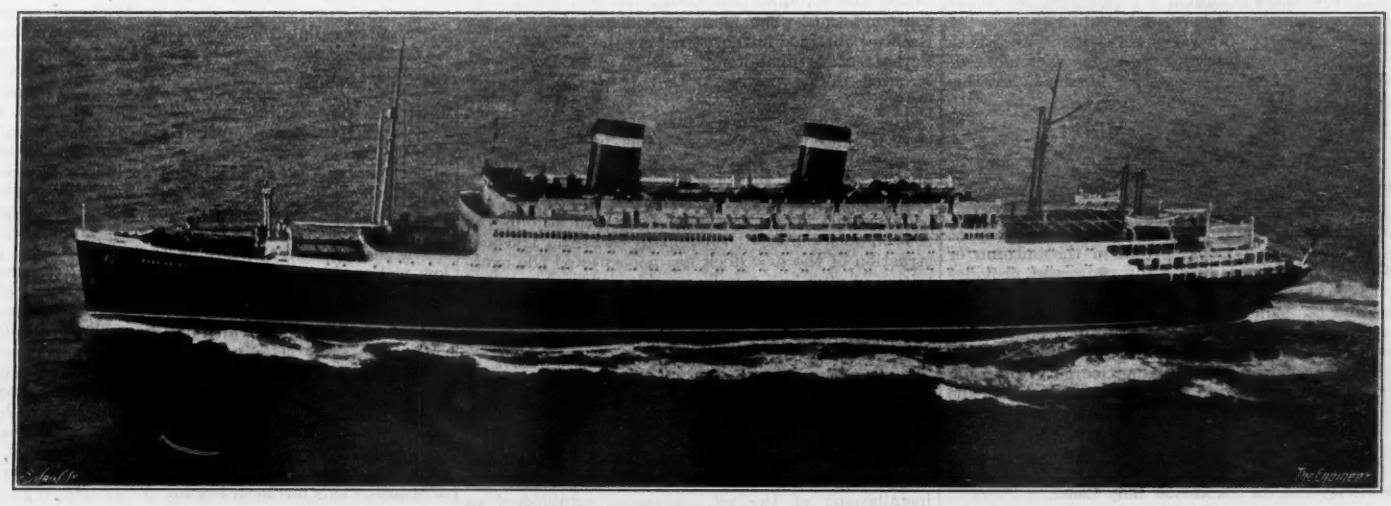


FIG. 8—THE UNITED STATES LINES 24,000-TON LINER "WASHINGTON"

Outstanding Foreign-Built Liners.

The largest liner under construction abroad is the C.G.T. liner "Normandie," at the Penhöet Shipyard, St. Nazaire, a view of which, in the fitting-out dock, is reproduced in one of to-day's Supplements. The illustration clearly shows the advanced state of the hull and superstructure and gives an indication of the original lines of the ship. For a complete description of this liner we have to refer our readers to THE ENGINEER of November 4th and 11th, 1932. We are able to state, however, that good progress has been made with the installation of the quadruple-screw electrical propelling machinery, which underwent satisfactory bench trials at the "Alsthom" works at Belfort. According to the statement of Monsieur Cangardel, made at the C.G.T. Company's annual meeting, held in Paris last autumn, the fitting out of the ship is proceeding very satisfactorily. Consider-

able thought has been given to fire prevention measures and other safety features. It is anticipated that the new liner will be commissioned in either April or May, 1935. According to Monsieur Cangardel's statement, both the owners and their engineers are of the opinion that she will cross the Atlantic at a speed exceeding her designed contract speed. As above mentioned, the design of the passenger accommodation has been largely influenced by new fire regulations which followed the disastrous fire on the "L'Atlantique." Although this fire occurred nearly a year ago, the ship is still the subject of litigation with regard to the payment of insurance money and the disposal or repair of the hull.

Two noteworthy German motor liners are the "Caribia" and "Cordillera," both constructed by Blohm and Voss, at Hamburg, for the West Indian services of the Hamburg-American Line. A view of the "Caribia" is given in one of our Supplements and a short account of her propelling machinery and other special features of design which have earned for her and her sister the name of "pocket liners" will be found in our issue of May 12th.

The only large American liner completed during the year is the cabin liner "Washington," which we illustrate in Fig. 8. She is a sister ship of the "Manhattan" and was constructed and engined at the New York Shipbuilding Company's yard, New Jersey. She has a length of 705ft., a beam of 86ft., and a depth of 47ft., with a measurement of about 24,000 gross tons, and is propelled by Parsons geared turbine machinery taking steam from 400 lb. pressure Babcock and Wilcox water-tube boilers.

Interest in Italy centred around the fine service performances of the new 50,000-ton liner "Rex" and the "Conte di Savoia." In August last the "Rex" made her fastest recorded passage across the Atlantic, only taking 4 days 16 hours 56 minutes between Gibraltar and the Ambrose Lightship, New York. Her average speed was 28·91 knots and her fastest day's run 736 miles at an average speed of 29·61 knots. The "Conte di Savoia" has given, we understand, good results in service and we are informed that the high-pressure Yarrow boilers have shown a high efficiency with a very low maintenance cost for upkeep of brickwork, &c., and easily cleaned tubes. The largest motor ship of the year was the 20,000-ton "Oceania," constructed for the Cosulich Line's Trieste, Naples and South American service at the Monfalcone Yard of the Cantiere Riuniti Dell' Adriatico. She, also, is illustrated in one of our Supplements. Her length is close upon 590ft., with a beam of 76ft. 6in. and a measurement of about 20,000 tons. She is propelled by a quadruple-screw arrangement of Fiat oil engines having a total designed output of 22,000 S.H.P. and giving the vessel an easy service speed of 19 knots and a maximum speed of over 22 knots. The same shipbuilders also completed towards the end of the year the motor liner "Calitea," a ship of about 4000 gross tons, propelled by Fiat oil engines. This liner has been built for the Lloyd Triestino services to India and the Far East.

An important ship built in Holland is the "Tricolor," constructed for Wilh. Wilhelmsen, of Oslo. She is a 6600 gross tons cargo vessel built by the Netherland Shipbuilding Company and engined with two-stroke double-acting Stork-Hesselman machinery. On her trials and in service she has maintained a speed of over 16 knots. During the year several Dutch steamers were converted to motor vessels, and Holland also has the distinction of building the largest and most powerful motor tug in the world. This vessel is the "Zwarte Zee," built by Smit, of Amsterdam, and engined by Werkspoor with 4200 H.P. motors driving the propeller through gearing and a hydraulic coupling.

(To be continued.)

Harbours and Waterways in 1933.

No. I.

THE year which has just closed has seen the virtual completion of most of the construction in home ports begun as the result of the inducement of financial assistance from public funds which reached its high-water mark about the end of 1930. The only works of importance still in course of construction which are aided to a material extent by grants from the Treasury are some of those at railway ports, such as the Southampton dock extensions. The year saw the completion of a number of the State-aided schemes, some of which we shall refer to hereunder. We called attention a year ago to the small number of Bills in Parliament by which powers for the construction of port works were sought, and there is no indication so far that the present session of Parliament will show any improvement in this respect.

THE UNITED KINGDOM.

Port of London.

The work carried out by the Port Authority during 1933 on capital account was probably of lesser extent than in any recent year. The new quay at the Royal Victoria Dock, begun in the autumn of 1932, was completed during the year, and provides berths for vessels discharging grain cargoes to the new flour mill built on the south side of the dock. The quay is 750ft. long and in front of and parallel to it there is an island jetty of reinforced concrete 350ft. long, similar to those in the King George V. Dock, on which pneumatic grain-discharging plant will be erected. The berth on the dock side of the island jetty has a depth of water of 28ft. and between it and the quay is space for berthing barges.

The Mersey and the Manchester Ship Canal.

The Mersey Docks and Harbour Board completed the first section of the Bidston dock works on the Birkenhead side of the river Mersey. We mentioned a year ago that the Dock Board had recently decided to curtail the expenditure on the Bidston works by reducing the length of the dock from 1600ft. to 1000ft., thereby effecting a saving of over £200,000 on the estimated cost. The future extension, at the west end of the section completed last year, will have a length of 1685ft. and a minimum width of 350ft. At present there are two quays, each 1000ft. in length, in the new dock, access to which is obtained from the West Float through a passage 100ft. wide, having a minimum depth of 30ft. of water over the sill. All the quay walls have been constructed of mass concrete. We printed a short description of the works in our issue of May 5th, following the opening of the dock on April 28th. Four bascule bridges built to carry roads and railways over the communicating passages of the remodelled Birkenhead docks have been completed and are now in use. The expenditure of the Dock Board on the Bidston works, including the equipment, one item of which is an electrically driven coal conveyor, which will be used mainly for bunkering purposes, has been about £700,000. The new sand pump dredger which the Dock Board ordered from Cammell, Laird and Co., Ltd., of Birkenhead, in 1932, has been named "Hilbre Island," and was brought into service in February. The dredging capacity of this vessel is 3500 tons of sand in 50 min. The Chairman, Mr. R. D. Holt, stated at a recent meeting of the Dock Board that the completion of the Bidston dock works and the reconstruction of the Central docks on the Liverpool side of the Mersey, which had been brought to a conclusion, left the Board with no important capital works in hand or in contemplation. The London, Midland and Scottish Railway obtained authority during the last session of Parliament to abandon the old Widnes Dock constructed under powers obtained in the reign of George IV.

The oil dock which for over two years the Manchester Ship Canal Company has had under construction at Stanlow, was completed and formally opened on May 26th by Mr. Oliver Stanley, the Minister of Transport. The dock is situated on the canal a mile above Ellesmere Port, and adjoins the first oil dock built by the company in 1922. The construction of the new dock has necessitated the excavation of over half a million cubic yards of rock and clay. It is 650ft. long by 180ft. wide. The depth of water is 32ft., and it is cut off from the water of the canal by a floating fire boom. Advantage has been taken of the construction of the new dock to make a wide approach to it and the adjoining No. 1 oil dock which serves as a turning basin of ample dimensions for all ships using this part of the Canal. The oil discharged at the berths in the oil docks is carried by pipes, passing under the Canal in a subway, to the south bank, where it is distributed to the installations of the oil companies established at Ellesmere Port.

The wharf at Irlam, begun in 1931, which the Ship Canal Company has built for the Lancashire Steel Corporation, Ltd., was also brought into use during the year, having been inaugurated on May 9th, when H.R.H. Prince George opened the Steel Corporation's new works adjoining the Canal. The wharf is about 600ft. in length, the depth of water alongside being about 28ft., and is equipped with ore unloaders and a transporter bridge with a span of 200ft.

When we recorded two years ago the opening of the Bromborough Dock on the Cheshire side of the Mersey, we mentioned that the reclamation of the foreshore was then in progress in the neighbourhood of the dock. Reclamation is still being carried on to the south of the dock, where a river wall nearly 3500ft. long has been built to retain dredged material which is pumped ashore from barges. Work has been begun on the building of silos for 10,000 tons of seed imports alongside one of the dock quays.

North-East Coast and Humber Ports.

The fish dock at Grimsby, begun by the London and North-Eastern Railway Company in conjunction with the Grimsby Corporation in 1930, made considerable progress during the year. The difficulties which were encountered in the construction of the foundations for the new entrance lock, owing to the presence of artesian water in the underlying strata, were overcome by the adoption of the same process of dewatering which proved so successful at Southampton during the building of the large dry dock at that port. The dewatering operations carried out both at Southampton and at Grimsby were fully described in a paper by Sir Henry Japp, which we published in our issue of October 27th. The Grimsby works are estimated to cost approximately £1,500,000, and include the construction of a fish dock with 4000ft. of quayage, ten slipways for the repair of fishing boats, coaling jetties and an entrance lock. A large area has been reclaimed from the foreshore of the Humber estuary. The ground within the area enclosed by the river embankment upon which the quays in the dock are to be built has been found to be of such a soft and treacherous nature that revised designs for the quay walls have had to be made. The building of the quays has now been begun. The new dock will add 37 acres of water space to the existing dock accommodation reserved for the fish trade of the port. The coal-shipping plant which the railway company has constructed on the site of an old staith in the Royal Dock at Grimsby was brought into use early in the year. It embodies the latest improvements in conveyor belt installations for the shipment of coal.

The Humber Bridge Bill, which, in spite of strenuous opposition from the river and navigation authorities, passed a Committee of the Commons in May, 1931, and was carried over into the 1932 session of Parliament, when it failed to proceed further owing to the withdrawal by the Government of the offer of financial assistance, came up for third reading in the Commons in February, 1933. The original scheme had by that time been radically altered by the promoters, and the Deputy Speaker ruled that the Bill could not be read a third time, and it was withdrawn.

The London and North-Eastern Railway Company completed during the year a varied programme of improvements at the St. Andrew's Dock, Hull, for the better accommodation of the fishing fleet. The river training works at Trent Falls, where the rivers Trent and Ouse unite to form the Humber, are making steady but slow progress. These works are being carried out by the Aire and Calder Navigation, the Humber Conservancy Board bearing a part of the cost. The latter body has recently agreed to make a further grant towards the cost of the river improvements, the original estimate of cost having already been exceeded. A further expenditure of £113,000 is needed to complete the works, which, under the Act authorising their construction, should be finished in July, 1934. Application is to be made to Parliament by the Navigation to extend the time for carrying out the improvements. Work was begun during the year by the contractors, Sir Robert MacAlpine and Sons, Ltd., on the dry dock at Wallsend, which they are building for Swan, Hunter and Wigham Richardson, Ltd., and to which we referred a year ago. The dock, estimated to cost £200,000, will have an internal length of 600ft. The President of the Board of Trade, Mr. Walter Runciman, on December 11th, formally opened the quay extension at Newcastle-upon-Tyne, which the Corporation had had under construction since February, 1931. The new work, which is of reinforced concrete, adds 700ft. to the quayage at Newcastle, now 6650ft. in length, under the control of the Corporation. The depth of water in the berths alongside the quay is 30ft. at low water of spring tides. The reinforced concrete deck of the superstructure has a width of 44ft., and the space available for transit sheds, railways and roadways, has a total width of about 200ft. from the river frontage. The cost of the new work has amounted to £87,000. The Corporation of Sunderland completed the construction of the deep-water quay wall in the river Wear, begun in 1931, but it will be some months before the quay itself is ready for use. The bunkering staith at the north end of the quay is now being erected and the construction of of transit sheds has been begun.

Coal shipments at Blyth in 1932 considerably exceeded those of the previous record year for that port, 1929. In consequence of this improvement in the staple trade of the port, an improvement which, unhappily, has not been shared by other coal ports, the London and North-Eastern Railway Company reopened in March two staith berths on the south side of the river that had been out of commission for about four years. The Cowpen Coal Company is constructing new staiths equipped with belt conveyors on the south side of the harbour opposite the west staiths. The new staiths, which will soon be ready for use, are to have 27ft. depth of water in the berths at low water of spring tides. The Blyth Harbour Commissioners are widening the tidal basin at the west staiths, thereby increasing the deep water area of the harbour by about 5 acres.

Southern Railway Ports.

The most spectacular work, to the completion of which we have to refer this year, is the Southampton dock extensions, which we described in a series of illustrated articles published in July. His Majesty the King opened the new dry dock at Southampton

on July 26th. At that time the dock had not been completed, and, although it had been flooded and gave admission to the Royal Yacht, it was not until the end of August that the sliding caisson, which closes the dock entrance, was placed in position. The equipment of the dock has now been virtually completed, and it is expected that the White Star liner "Majestic" will be docked in it in the present month. It will be remembered that the building of this great dock was begun in May, 1931, with the purpose of receiving in the autumn of 1933 the 73,000-ton Cunard liner which had been laid down at Clydebank; but, not long after the construction of the dry dock had begun, the decision to suspend work on the new vessel was announced. It is now about to be resumed at Clydebank, but it will be two years before the dry dock is called upon to accommodate the great ship. The dock is among the largest, and in some dimensions certainly the largest, of dry docks already built or building in any part of the world. Its length of 1200ft. is not surpassed, and the only dry dock having a greater width at the entrance is the combined lock and dock built to accommodate the French liner "Normandie," at St. Nazaire, opened in 1932, which has a width of 164ft. The Southampton dock has a greater depth over its sill and blocks at high water of spring tides than any other dry dock, except that at Le Havre, opened in 1927. This last comparison is, however, misleading, because at Southampton the tidal rise is small in comparison with that at Le Havre, and both at high water of neap tides and at all low waters, the available depth at Southampton far exceeds that of the Le Havre dry dock.

The new deep-water quay at Southampton, which has a total length of about 1½ miles, is nearing completion. At the time of the King's visit to Southampton in July the sinking of the last of the giant monoliths for the construction of the quay wall had been begun. All of them have now been sunk to the required depth and the building of the wall superstructure is nearing completion. Several of the liner berths at the deep-water quay have been in use throughout the past year, and fully one half of the 415 acres of reclamation at the back of the quay has been completed; two transit sheds, each 1000ft. long, are already in use, and a contract has recently been placed by the Southern Railway Company for the construction of a second pair of passenger and cargo sheds, having a combined length of 1274ft. When the quay is fully equipped there will be at least eight sheds extending along the quay frontage. About one half of the berths in front of the quay has been dredged to a depth of 45ft. at low water of spring tides, and the other half of the quayage has a depth of 40ft. at low water. The total cost of the docks extension scheme is estimated to be eight million pounds, inclusive of equipment, sheds, and railways. This expenditure, of course, includes also the reclamation of foreshore and mudlands to form the site upon which the dock extensions have been constructed. It may be noted in passing that the German Transatlantic liners, which formerly anchored in Cowes Roads for the transference of passengers and mails, now come up to Southampton and berth at the new quay. The first Norddeutscher-Lloyd liner to make use of the quay, on May 14th, was the "Bremen."

The Southern Railway Company made a beginning in August with the construction of the terminal facilities at Dover for the train-ferry service between that port and Dunkirk, for which they obtained Parliamentary powers in 1932, by placing a contract with Messrs. Nuttall and Mowlem for the building of a dock near the inner end of the existing Admiralty pier. The ferry dock, which will be closed by two gates of the "Box" flap type, is to be 415ft. long by 72ft. wide, and will accommodate one ferry boat. This closed dock is to be operated in the manner of a lock, the level of the water in it being raised or lowered as required so as to bring the rail tracks on the ferry boat approximately to the same level as those on the shore. The contract for the construction of the three train-ferry vessels was placed with Swan, Hunter and Wigham Richardson, of Newcastle-upon-Tyne, in July. It is expected that these vessels will be completed ready for service during the coming summer. The cost of the service, including the Dover terminal and the vessels, is estimated to be about three-quarters of a million pounds. Another train-ferry project has recently been revived. It is reported that a French company has acquired from Pearson and Dorman, Long, Ltd., the war-time train-ferry terminal at Richborough, and proposes to run a train-ferry service between Richborough and Calais, where the ferry terminal constructed in 1917 for war service is still available. It is intended to operate the new service for the transport of fruit, vegetables, and other perishable goods. A considerable amount of dredging will have to be done at Richborough before the ferry boats can make use of the old berth.

The Dover Harbour Board completed in May the removal of one of the block-ships sunk during the early days of the war in the western entrance to Dover Harbour. The work of removal was begun in the spring of 1931. The second block-ship, that lying on the eastern side of the entrance, has not yet been removed.

Bristol Channel and South Wales Ports.

The report of the Severn Barrage Committee was issued in March, and has been reviewed in this journal on more than one occasion. Its interest in relation to harbours and waterways lies, firstly, in the proposal to form a huge enclosed harbour area above the barrage, access to which would be gained through locks, and, secondly, in the effect of the barrage, if it should ever be constructed, on the estuary channels, and particularly on the approaches to the ports of Avonmouth and Newport. There does not seem, however, to be much prospect of the materialisation of this vast scheme, estimated to cost over 50 million pounds.

The Great Western Railway Company is still engaged in carrying through its programme for the modernisation of the equipment of the South Wales docks. The company is making strenuous endeavours to induce the South Wales coalowners to expedite the introduction of 20-ton wagons, and proposes to construct 5000 such wagons which will be let out on hire to the collieries. It has been stated that there are now eighty-one shipping appliances in the South Wales ports capable of tipping coal from 20-ton wagons.

Scotland.

The new graving dock at Elderslie on the Clyde, which has been built by Sir Robert MacAlpine and Sons, Ltd., for Barclay, Curle and Co., was opened in January. The dock has an internal length of 620ft. and a width at the entrance of 85ft., with a depth over the sill of 28ft. at M.H.W.S.T. The entrance is closed, not by ordinary mitre gates or a caisson, but by a "Box" type flap gate turning about a hinge at sill level. We described and illustrated the Elderslie gate in our issue of February 17th last.

We recorded a year ago that the widening of the Clyde at Clydebank, for the passage down the river of the new Cunard liner, had already been completed just before the suspension of work on the vessel in December, 1931. The deepening of the river in the neighbourhood of the building berth which will be necessary before the ship can be launched was, at the same time, postponed, but it will now be undertaken by the Clyde Trustees in view of the intention to resume work on the vessel with the aid of the Government grant which was announced in December. The Clyde Trustees have, since 1920, when the work of reconstruction was begun, rebuilt no less than 4875 lineal feet of their quayage on the south side of the river forming (except for a small break at Finnieston Ferry) a continuous length of quay wall having a depth of water of 24ft. or more at low water of spring tides where formerly the available depth was 15ft. or less. The Plantation Quay was finished in May, and all work on the General Terminus Quay—the last section of the reconstruction—is expected to be completed during the coming summer.

Ireland.

The harbour extension on the County Antrim side of the river Lagan at Belfast was formally opened by the Duke of Abercorn, the Governor of Northern Ireland, and the naming ceremony of the new channel and basin was performed by Princess Alice, Countess of Athlone, on October 26th. The approach channel from Belfast Lough and a considerable part of the large open basin have been dredged to a depth of 30ft. at low water. The basin is about 2600ft. long, over 1000ft. of it having a minimum depth of 30ft., and the remainder of 23ft. at low water. The works have been carried out by the Belfast Harbour Commissioners with the assistance of a grant from the Northern Ireland Government. It was stated in the course of the inaugural ceremonies that the net tonnage of shipping entering the port had increased from just over 5 million tons in 1921 to 7¼ million tons in 1932, and the import of goods had grown from 2¼ million tons in 1921 to over 3 million tons in 1932.

Other Ports of the United Kingdom.

Work is still in progress on the extension of Parkeston Quay at Harwich, begun in October, 1931, by the London and North-Eastern Railway Company. It is unlikely that the new quay, which will have a length of 1200ft., will be brought into use until the autumn of 1934. The railway company placed a contract in August for a transit shed and other buildings which will form a part of the extension works. The transit shed is a double-deck structure, 900ft. long by 62ft. wide, and between it and the quay face there will be three lines of railway track, and the quay is to be equipped with twelve electric cranes. The quay will provide berths for three additional vessels, bringing the total number of steamship berths at Parkeston to eleven. It is expected that these improvements will cost approximately £500,000.

The new lock, which has been built by the Shoreham Harbour Trustees to give access to their wet dock, was opened by Prince George on March 15th. The lock, which is 230ft. long by 40ft. wide, replaces an old and much smaller structure built nearly eighty years ago, and will enable colliers of larger capacity than has hitherto been possible to reach the quays at the important electric power station of the Brighton Corporation in Shoreham Harbour. The cost of the works is in the neighbourhood of £100,000.

The Prince of Wales visited Weymouth on July 13th to inaugurate the reconstructed North Pier at that port. The work, which has cost about £150,000, has been carried out jointly by the Great Western Railway Company and the Corporation of Weymouth, with the assistance of a Government grant. The work was begun in 1931 and includes, in addition to the rebuilding and extension of the steamboat pier, nearly a quarter of a mile in length, the development of an area on the north side of the structure for pleasure purposes. The reconstructed pier and its extension are of reinforced concrete.

The two new sea-locks at Ardrishaig and Crinan, on the Crinan Canal—one of the two canals owned and operated by the Ministry of Transport—were brought into use in the course of the year.

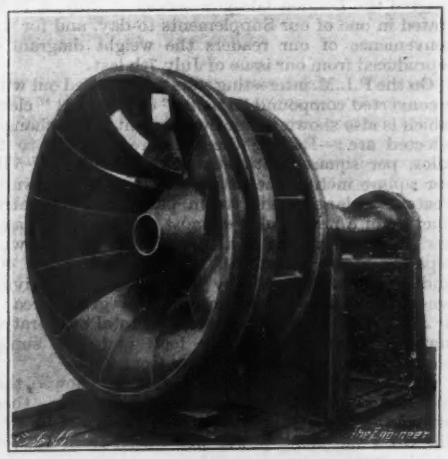
Inland Waterways of the United Kingdom.

The programme of reconstruction begun by the Grand Union Canal Company in 1932 made considerable progress during the year. Some of the new locks which will take the place of the old narrow locks have already been completed. The new locks permit the passage of boats of 12ft. 6in. beam, and between Napton and Knowle, in Warwickshire, fifty-one of them have been built. The expenditure involved by these improvements is expected to be about one million pounds, and some assistance has been received by the company from the Government.

(To be continued.)

Turbine Runners for Arapuni, N.Z.

AN interesting order for the improvement of a large hydro-electric installation in New Zealand has recently been received by the English Electric Company through its agents, Messrs. Cory-Wright and Salmon, of Wellington. The Arapuni hydro-electric power station of the New Zealand Public Works Department contains at present four 25,000 B.H.P. hydro-electric generating sets of the vertical shaft type. The plant will ultimately have a capacity of 200,000 B.H.P. Arapuni is the principal power station operating on the main distributing system



TURBINE RUNNER FOR NEW ZEALAND

in New Zealand, and it was recently decided to replace two of the runners supplied by the original makers. Tenders were called for, and the order for the new runners was placed with the English Electric Company, which had several years previously installed turbines in Canada and Scotland designed to run under similar conditions. The two replace runner wheels will be for all practical purposes replicas of the runner wheel shown in the accompanying engraving, which was supplied by the English Electric Company six years ago for the Alouette plant in British Columbia. The two new runners for Arapuni will each consist of one solid casting in fine-grained steel specially treated to withstand the exacting conditions in service. They will be made at the Rugby works of the company, and British material throughout will be employed. Each runner and shaft will weigh 15 tons. The contract was obtained against severe competition from abroad.

BOOKS RECEIVED.

The Book of Stainless Steels. Edited by E. E. Thum. Cleveland, Ohio: The American Society for Steel Treating, 7016, Euclid-avenue, U.S.A. Price 5·00 dollars net.

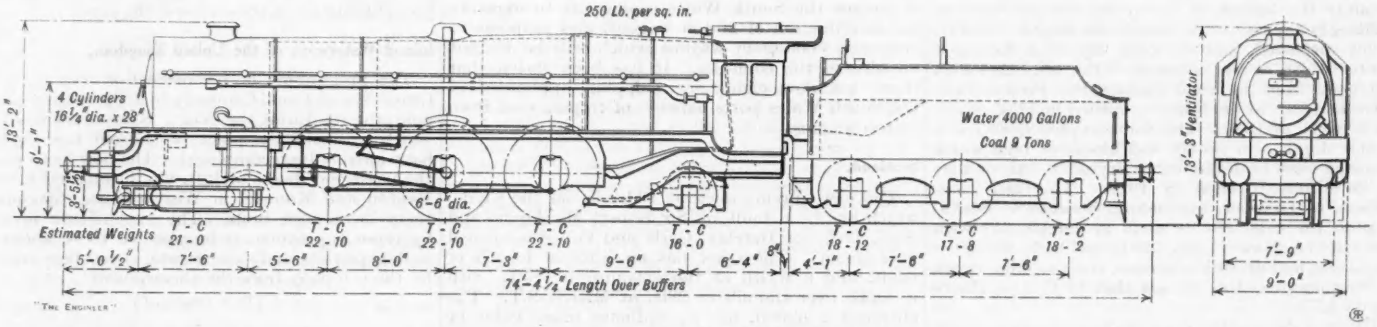
Process of Seamless Steel Tube Manufacture. By R. S. Betteridge. London: The Draughtsman Publishing Company, Ltd., 96, St. George's-square, S.W.1. Price 2s. net.

Qualitätsteigerung im Werkzeug- und Feinmaschinenbau: Gedanken und Vorschläge. By C. Büttner. Berlin: V.D.I.-Verlag G.m.b.H., Dorotheenstrasse 40, N.W.7. Price 1.70 marks.

Steinbearbeitung. By Dr.-Ing. K. Röder, Dr.-Ing. W. Gruner, Dr.-Ing. W. Werner, und Dr.-Ing. G. Pahlitzsch. Berlin: V.D.I. Verlag G.m.b.H., Dorotheenstrasse 40, N.W.7. Price 6.75 marks net.

New Locomotives of 1933.

AS far as steam locomotives were concerned, it was a blank year, both for the railway companies and the builders, only two engines of new design appearing on British railways. That does not mean that progress ceased, but it so happens that a couple of very interesting engines about which it is too soon to say more than that one is a "Mikado" and the other a non-condensing turbo-locomotive were begun by two companies, but will not be completed for some months. The British engines of the year were undoubtedly Mr. Stanier's "Princess Royal," and her sister "Princess Elizabeth," "Pacifics," with 6ft. 6in. drivers and four 16½in. by 28in. cylinders, giving, with 85 per cent. of the working pressure of 250 lb., a tractive effort of 40,000 lb. The first of these engines, which entered the London–Glasgow service in July, is illustrated in one of our Supplements to-day, and for the convenience of our readers the weight diagram is reproduced from our issue of July 7th last.



Boiler.—Barrel, 20ft. 7$\frac{7}{16}$in.; diameter outside, 5ft. 9in., increasing to 6ft. 4$\frac{1}{4}$in.

Fire-box.—Outside, 8ft. 6in. by 7ft. 1in. and 6ft. 1in.; inside, 7ft. 7$\frac{1}{8}$in. by 6ft. 1in. and 5ft. 2in.; height, 6ft. 8$\frac{3}{8}$in. and 5ft. 2$\frac{1}{8}$in.

Tubes.—Superheater elements, sixteen 1$\frac{1}{8}$in. diameter outside by 11 S.W.G. Large tubes, sixteen 5$\frac{1}{8}$in. diameter outside by 7 S.W.G. Small tubes, 170 2$\frac{1}{4}$in. diameter outside by 11 S.W.G.; 20ft. 9in. between tube plates.

Heating Surface.—Tubes, 2523·0 square feet; fire-box, 190·0 square feet; total, 2713·0 square feet; superheater, 370·0 square feet.

Grate Area.—45·0 square feet.

Tractive Effort.—40,300 lb.

	Engine. t. c. q.	Tender. t. c. q.
Weight light	—	—
Weight loaded	104 10 0	54 2 0
Total weight of engine and tender light	—	—
Engine and tender loaded	158 12 0	158 12 0

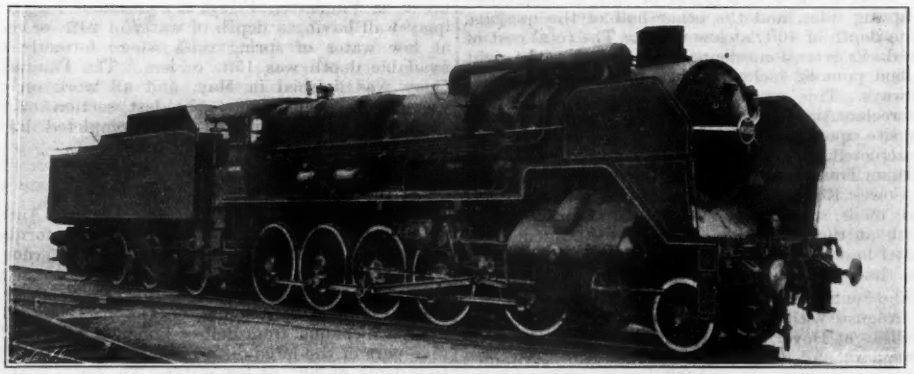
L.M.S. PASSENGER LOCOMOTIVE "PRINCESS ROYAL"

On the P.L.M. interesting tests were carried out with a converted compound "Pacific" of the "231" class, which is also shown in our Supplement. The changes effected are:—Raising the pressure from 16 to 20 kilos. per square centimetre (227·5 lb. to 284·5 lb. per square inch); the fitting of a Dabeg feed-water heater; enlarging the steam passages; the introduction of a new double exhaust and variable blast; and the employment of a "superheat collector with separate steam chambers." The cylinders are 400 and 650 mm. diameter by 650 mm. stroke, driving wheel 2 metres in diameter. The grate area is 4·25 m². (about 46 square feet), the total evaporative surface about 2500 square feet, and the superheater surface about 480 square feet.

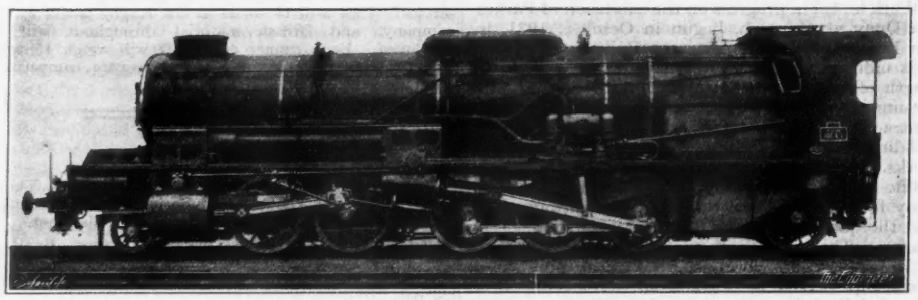
Tests made with a dynamometer car showed that material improvement had resulted from these changes. As compared with a normal "Atlantic," the draw bar horse-power was raised from 1600 to nearly 2200, or by about 35 per cent., and for runs of 20 kiloms. or so an indicated H.P. and a d.p.h.p. of 2933 and 2397 respectively were developed with 55 per cent. admission and at a speed of 100 kiloms. per hour. For the same power and the same speed there was a small reduction of coal consumption, whilst the improved draught enabled a better fire to be maintained. Subsequently the engine drew a train of 430 tons—including the dynamometer car—between Paris and Lyons, a distance of 510·9 kiloms., for which 5 h. 15 min. are scheduled, but which, allowing for a voluntary extension of a stop at Laroche, could have been covered in 5 h. 7 min. A speed of 120 kiloms. per hour was maintained between Cesson and Laroche, and leaving the latter place the same speed was reached in 7 min. after a run of 9 kiloms. In fact, for 100 kiloms. an average speed of 120 kiloms. per hour was maintained, a speed of 133 kiloms per hour being reached at certain points. The coal consumption was 7·5 tonnes, and 59·3 cubic metres (say, 13,000 gallons) of water were used.

As a matter of interest we illustrate also one of the ten engines of the "151" class, actually put into service by the P.L.M. in 1932, but modified by the introduction of the double chimney last year. These engines, remarkable for their wheel arrangement, develop nearly 2900 H.P. at the draw bar.

Another illustration in our Supplement shows the latest compound high-speed goods engine on the Paris–Orleans Railway. It has 71in. drivers and cylinders 17·3in. and 25·2in. by 25·6in., with a boiler pressure of 285 lb. per square inch. The total evaporative surface is about 2300 square feet, and the grate area about 41 square feet. This engine has also a double chimney. The total weight in running order, engine alone, is 106 tons, and the weight on the drivers 75·5 tons. In the remaining illustration in the Supplement page will be recognised the "Mountain" type engine of the Etat, described in our issue of May 19th last. This engine is designed for hauling 600-ton trains between Paris and Cherbourg in four hours. It has three high-pressure cylinders with poppet distribution valves and an automatic stoker on a grate of only 54 square feet. The boiler has nearly 3000 square feet of evaporative surface and a superheater with 920 square feet. The working pressure is 285 lb. per square inch. The valve gear is of the cam-operated Renaud type.



NORD—FOUR-CYLINDER COMPOUND HEAVY GOODS ENGINE



P.L.M. CLASS 151 LOCOMOTIVE REMODELLED

The illustration given on this page of a Nord engine represents a new design of which thirty examples are being constructed. It is a four-cylinder compound, and though primarily designed for very heavy goods trains—up to 2200 tons—and speeds up to 70 kiloms. per hour, its employment on heavy express trains has been kept closely in view. It has two outside high-pressure cylinders, 19·9 by 25·2, and two inside low-pressure cylinders, 22·8in. by 27·5in. The working pressure is 256 lb. per square inch, and the maximum pressure in the receiver 114 lb. per square inch. The coupled wheels—five axles—are a little over 59in. in diameter, and the weight of the engine in running order is 104 tons, with 90 tons on the coupled wheels. The superheat employed is between 380 deg. and 390 deg. Cent. normal, but may be taken up to 420 deg. Cent.

Whilst the railcar, driven by an internal combustion engine, is making definite progress on British railways for shuttle services, the oil locomotive proper is advancing more rapidly in other countries than this, and no engines of new design were actually purchased by British railways during the year, but a small oil-electric locomotive, 250 H.P., made by Harland and Wolff, Ltd., was delivered in the spring to the Belfast and County Down Railway. The most important engines of the year were built by Sir W. G. Armstrong, Whitworth and Co., Ltd., and were described in our issues of November 17th and 24th. The first of these is being tried in service on the L.N.E.R. It is an oil-electric, and being capable of developing 880 H.P. is deemed to be suitable for the majority of expresses and for heavy goods trains. It weighs 72 tons in working order, and has a maximum axle load—three driving axles—of 17 tons. Its tractive effort is given as 28,500 lb., and its length is 36ft. 6in. over the buffers. The engine is an Armstrong-Sulzer, with eight cylinders; the generator is by Laurence Scott, and the three traction motors by Crompton-Parkinson.

The other Armstrong oil-electric locomotive forms part of a train for rapid and frequent services between Santos and San Paulo—roughly 49 miles—in Brazil. The train consists of three coaches with the power unit articulated to the first. This unit is not strictly a "locomotive," but as two traction motors are carried on it we honour it with that name. Two more motors are carried on the last bogie of the train. The engine is a six-cylinder Armstrong-Sulzer, running at 750 r.p.m., and the maximum train speed is 65 m.p.h. The complete train, loaded with 168 passengers and luggage, weighs nearly 104 tons.

Two new factories have been established in the Bombay Island for the manufacture of bakelite electrical fittings. Two further factories for manufacturing bakelite accessories in the Bombay Presidency are now under consideration.

Bridge Construction in 1933.

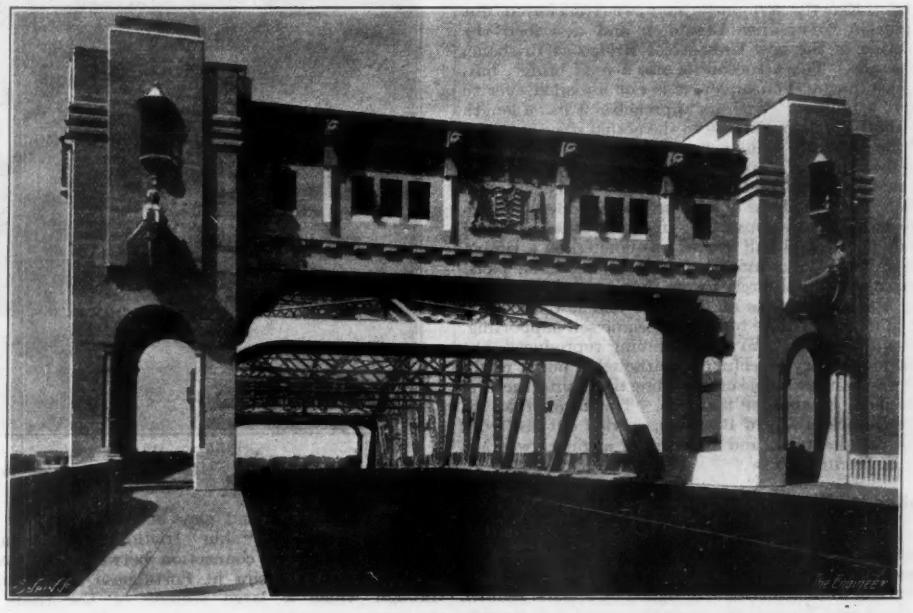
THE opening of the year 1933 coincided with the very depth of the world depression, and even though there are now manifest signs of improvement, it is somewhat strange to find that not only have a number of fine bridges been completed in various parts of the world, but also that work upon several others has been started. Nevertheless, the position can hardly be described as satisfactory, when, as happened in May, a Memorandum on Bridge Building, presented to the Minister of Transport by the British Steelworks Association could state: "It is an astonishing fact that in a country so highly industrialised as this, with a rapidly expanding transport system, no bridge of any magnitude is being started." Apart from large bridges, the position as regards the building of smaller ones was also far from satisfactory throughout the year. There can be little doubt, as was pointed out in the Memorandum to which reference has been made above, that if the full benefit of the expenditure in recent years upon road construction is to be felt, a very large number of minor bridges will have to be strengthened or rebuilt in the near future. Unfortunately, since the financial crisis of 1931 the Ministry of Transport has been unable to make grants towards such work with so generous a hand, and the progress of these works has necessarily suffered.

Late in the year the position in this country as far as large bridges were concerned was considerably improved by the decision to build two structures of considerable magnitude in Scotland, one spanning the Clyde and the other the Forth. The project for the Finnieston Bridge at Glasgow has been under discussion for many years, and its construction was authorised by Parliament more than six years ago. We are now informed that the preliminary work is in hand. At an expenditure estimated at £327,000, the Forth is to be spanned at Kincardine, and the contract for the construction of the bridge has been let to the Cleveland Bridge and Engineering Company, Ltd., of Darlington. The bridge is to have fourteen steel spans, each of 100ft., nine 50ft. spans of reinforced concrete, with a horizontal swing span giving two clear openings of 150ft. over the navigable channel. The consulting engineers are Sir Alexander Gibb and Partners. No further progress was, however, made during the year towards the building of either the Charing Cross Bridge in London or the Humber Bridge at Hull, both of which might by now be partly constructed had it not been for the coming of the depression and the consequent inability of the Government to make grants towards their costs.

San Francisco Bridges.

Although the completion of no such great bridge as that over Sydney Harbour can be credited to the year 1933, several works of major importance have been constructed abroad. In America particularly the great and continuous development of road transport has resulted in recent years in a spate of bridge building, and since the natural features of the land are formed on the large scale, many of these structures are of considerable magnitude. The year 1933 in that country, however, is more likely to be remembered as that during which the construction of two great bridges at San Francisco was started than by reason of the completion of any other structure. The Golden Gate Bridge is to span the mouth of the San Francisco harbour itself, and will be exposed when built to the force of gales from the Pacific Ocean. It is to be of so colossal a size that even in the land of "hustle" the project for its construction has only reached fruition after fifty years of discussion. Nor is the delay surprising, for until recent years it has been more than doubtful whether the abilities of designers and the discoveries of metallurgists were sufficiently developed to encounter the problems involved, with any expectation of success. The great central span, owing largely to the depth of water in the main channel, has to have a length of no less than 4200ft., and will be flanked upon each side by a span 1200ft. long. Long approach viaducts will connect up the bridge to existing roads at each end. Under the greater part of the central span there will be 210ft. of headroom for shipping using the harbour. The original design put forward was of the cantilever-suspension type, but subsequent study of the conditions has led to the abandonment of the cantilever feature and the adoption of a full suspension arrangement. While the main pier at the northern end can be founded on rock lying only a few feet below the water and close inshore, the corresponding pier at the other end will be situated 1000ft. from the shore, at a point where the depth of water is 75ft. This pier will have to be constructed to withstand the force of heavy seas rolling in from the Pacific. Some of the most impressive figures available illustrating the progress that has been made by cable makers are those referring to the main cables, which, when compacted, will be 36½in. in diameter and 7660ft. long between anchorages. The bridge is to carry a roadway, 60ft. wide, and there will also be two footpaths which ultimately it is intended shall carry electric trolley cars or the like. Much pedestrian traffic is not expected, as it will take about half an hour to cross the bridge when walking fast! Up to date, little more than preparatory work has been put in hand.

A glance at the map suggests that the San Francisco–Oakland Bridge is to be of even greater proportions than its neighbour, but in actual fact it is its length—7 miles—rather than any other feature that is impressive. It will cross the harbour in two stages. From San Francisco to Goat Island there are to be two consecutive suspension bridges with main spans of 2310ft., a central pier acting as an anchorage for both sets of cables. After tunnelling for 540ft. through the island, the roadway will emerge on to another bridge consisting of a central cantilever span of 1400ft., two side spans of 512ft., five through truss spans, and a long viaduct leading into Oakland.



PORTAL TO CENTRAL SPAN OF BURRARD BRIDGE, VANCOUVER

Burrard Bridge.

Further north along the same coast but in Canada, there was completed in Vancouver a fine road bridge, the portal to the central span of which is illustrated by the accompanying engraving. This—the Burrard Bridge—is wide enough to carry six lines of traffic, and has been built in such a manner that at some later date it will be possible to carry a railway across beneath the road. It was designed to replace a trestle bridge across False Creek, the city's secondary harbour, and connects the business district with the

THE GREY STREET BRIDGE AT BRISBANE, AUSTRALIA

large residential area south of English Bay without interfering, as does the trestle bridge, with navigation. As it stands high and prominent above the city, critical consideration was given to its architectural features. Its arrangement is symmetrical. There are two deck truss spans on each side of a through truss channel span, with reinforced concrete approach viaducts, giving a total length between abutments of 2817ft. 6in. The erection of the central through span was complicated by the necessity of leaving clear a channel 90ft. wide for navigation. The work was carried out for the most part on timber trestles, and the channel was kept clear by cantilevering out the end of the span to meet the pier.

An Australian Bridge.

We described the Burrard Bridge at the end of January, and strictly it cannot be regarded as a 1933 bridge, having been opened for traffic in the previous year. Exactly a month later we transferred our attention to another Dominion and described the erection of the new Grey-street Bridge at Brisbane, Australia. This structure is also a road bridge, but, unlike that at Vancouver, it is not intended ever to carry a railway. With its approaches it has a length of 1634ft. and consists, as to the actual river crossing, of three exactly similar arch spans, each 238ft. long. At first sight it seems to be constructed throughout of monolithic concrete, but this appearance is deceptive. The nakedness of steel arches is hidden beneath pre-cast concrete voussoirs. In course of construction each of the steel half arches was erected on a timber staging built out into the river between the piers. Two opposed half arches were then hoisted up, rotating about pin joints at the piers and lowered away until meeting at the top they became self-supporting. As will be seen from the engraving reproduced, the design is a very graceful one, although a purist might object to the principle of shrouding the main structural members in another material. The firm of M. R. Hornibrook, Ltd., of Brisbane, carried out the work and the designing and supervising engineer was Mr. A. E. Harding Frew.

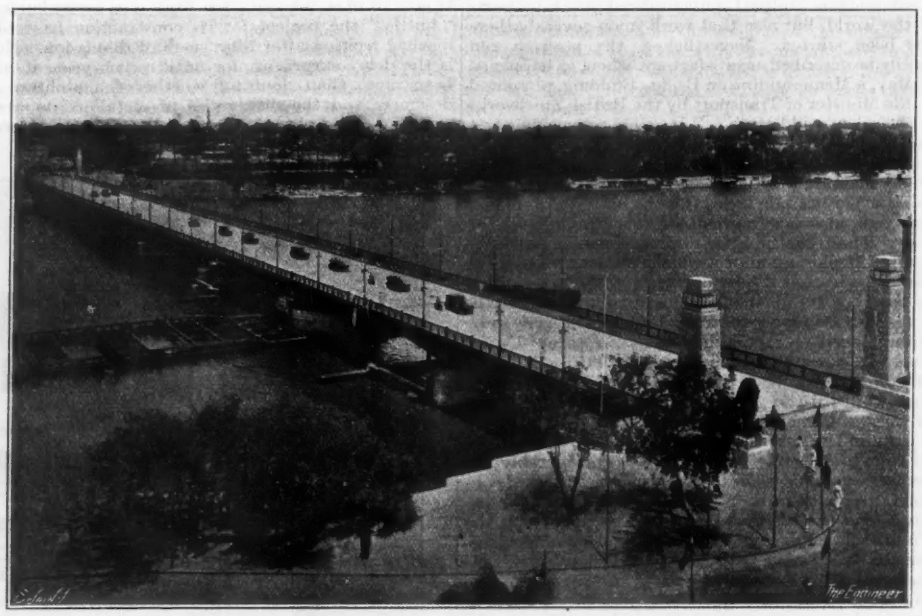
India.

The British Empire in 1933 seems to have been particularly rich in bridge construction. In India several structures were erected. A railway bridge over the river Jumna at Delhi, designed by Messrs. Rendel, Palmer and Tritton, and recently completed, consists of twelve main spans, 214ft. long, and two approach spans, the steel work for which was fabricated at the Calcutta works of Braithwaite and Co. (India), Ltd. It carries the lines of the North-Western Railway Company of India. The bridge replaces the old down line of the existing structure and carries on its upper deck a single broad-gauge heavy mineral track, whilst a lower deck supports a roadway. Erection was undertaken by the railway company, which made use of the main trusses of the existing bridge for the purpose. In the same country, by the same engineers and builders, there is being erected 200 miles above Bombay, a bridge over the Nerbudda River to carry the lines of the Bombay, Baroda and Central Railway. It will replace an existing single-track bridge, which on its completion will be converted to carry road traffic. Fifteen double-track spans at about 288ft. centres of piers and one similar span of 252ft. are carried on reinforced concrete piers, each consisting of a pair of cylinders 18ft. in diameter standing on well kerbs 22ft. in diameter and 34ft. 8in. centres apart. The kerbs are to be sunk to about 110ft. below mean water level or about 160ft. below rail level This labour is rendered necessary by the unstable formation of the river bed.

Africa.

One of the many countries of the world which provide great opportunities for civil engineers is Egypt. At Cairo, early in June, an important new bridge across the Nile was opened by King Fuad. The designs of the Khedive Ismail Bridge, as it is named, were prepared by Dorman, Long and Co., Ltd., in conjunction with Sir John Burnett and Partners as architects, and the new structure replaces the old Kasr-el-Nil Bridge, originally built in 1871 and of recent years found inadequate to meet the increased volume of traffic and heavier loading it has been called upon to bear. The new bridge, 66ft. wide and 1260ft. long, crosses the river on eight spans and is a handsome work, as may be seen from the photograph reproduced on this page. The spans are of steel in the form of elliptical arches and no structure above deck level impedes the view from the roadway. Granite faced piers carry the steel work. Two clear passages, 66ft. in width, for the accommodation of river traffic, are provided by an electrically operated swing span. Granite pylons flank the abutments and the four large bronze lions arranged beneath them were taken from the old bridge. If allowance is made for the customary suspension of operations during high flood periods, the actual time occupied in the removal of the old bridge and the erection of the new works out at eighteen months.

On the same Continent there is being constructed a great bridge across the Zambesi. When completed this structure with its approach viaducts will be just over 2¼ miles in length. The contractors are the Cleveland Bridge and Engineering Company, Ltd., of Darlington, and Messrs. Livesey, Son and Henderson, and Messrs. Rendel, Palmer and Tritton are the consulting engineers. The completed structure will consist of six approach spans each 66ft. 6in. long, thirty-three main spans 262ft. 6in. long, seven smaller spans of 165ft., and a viaduct with a length of 1805ft. Since very few of the piers supporting the bridge can be founded on rock the foundations for the remainder will have to be sunk to a sufficient depth in the sand and clay of the river bed to make dependence on "skin" friction safe. The new bridge will facilitate connection between Nyasaland and the port of Beira in Portuguese East Africa through which a large volume of the trade of the former country is carried on. At present the difficulties of ferrying goods across the Zambesi cause delays and the ferry service is liable to interruptions at times of flood.



THE KHEDIVE ISMAIL BRIDGE AT CAIRO

European Bridges.

At this time last year we were unable to find in the whole Continent of Europe exclusive of this country a single bridge worthy of note. During 1933, however, there was completed in Italy the Mestre-Venice bridge-road, which we described so recently that no further reference to it is required here; while in Sweden a very interesting bridge is now approaching completion. The Traneberg arch bridge, to which we refer, spans the harbour of Stockholm and will replace a pontoon bridge which was opened for traffic twenty years ago, but which is now found inadequate to meet modern requirements. As will be seen from the engraving in the Supplement, the appearance of the new bridge is likely to be worthy of its setting. Including the viaduct and approaches, it has a length of 580 m. The most interesting fact, however, is that the arch itself has a clear span between abutments of 178·4 m., greater than that of any other reinforced concrete arch yet built. A clear headway for shipping of 26 m. above mean high water level over a width of 45 m. is made available, and the bridge is designed to carry a roadway and the two tracks of the suburban electric railway. The false-work or scaffolding employed for the construction of the twin concrete arches of which the main span is composed, consisted of a steel arch. After being used for the construction of one concrete arch it was moved laterally and used again for the erection of the second. A full, illustrated description of the methods of erection employed was given in an article appearing in our issue of September 15th. A feature of interest is the independence of the two arches. As the bridge is aligned almost due east and west, there may at certain times be an appreciable elevation of the crown of the south arch above that of the north arch owing to a temperature difference. As far as the rail tracks supported by the bridge are concerned this difference of level will be of no consequence, as they are wholly carried by one arch, but the roadway, while principally carried by the one is also in part supported by the other. Articulation of the road surface is therefore provided for, the joint between the two arches being masked by a steel cover plate. The Engineering Department of the Stockholm Harbour Board was responsible for the design of the bridge and its erection is being carried out under the supervision of that body.

In May it was announced that the whole contract for the construction of bridges connecting the islands of Falster and Zealand in Denmark had been awarded to Dorman, Long and Co., Ltd., of London and Middlesbrough. In forming the connection, use is to be made of the small island of Masnedö, so that the whole construction falls naturally into two parts—the Storström bridge, approximately 2 miles in length, between Falster and Masnedö, and the Masnedsund bridge, about ½ mile long, connecting the small island to Zealand. Both bridges when completed will carry a roadway about 18ft. 6in. wide between kerbs, a footway 8ft. wide, and a single track, 4ft. 8½in. gauge, railway. In all, there will be fifty spans in the Storström bridge, the centre three of which will be 350ft., 450ft., and 350ft. long between piers respectively, and will allow a headroom of about 85ft. for shipping.

English Bridges.

In the British Isles, and particularly as a result of the great development that has taken place in the making of new roads and the improvement of old, bridge construction and reconstruction is becoming ever more necessary. Unfortunately, as we mentioned in an introductory paragraph, a hard-hit Treasury found itself unable in many cases to make grants towards the execution of such works, and in consequence many schemes have had to be pigeonholed for the duration of the depression. Nevertheless, several bridges of the type under discussion were completed during the year. There is, for instance, the new steel bridge at Fladbury, carrying an unclassified road over the river Avon on three spans, 49ft. 10½in., 100ft. 3in., and 49ft. 10½in. in length respectively, and designed by Mr. B. C. Hammond. The cantilever girders, supplied by the Chepstow Wagon and Constructional Works, Ltd., are spaced at 23ft. 4in. centres and supported on rocker bearings on four cylindrical river piers.

A more important structure of the same class carries a new main road over the river Clyde between Motherwell and Hamilton, and consists of three skew spans, each at 116ft. centres of bearings. It has a 350ft. clear span between abutments measured on the skew. A 60ft. roadway and two 10ft. footways are accommodated. The ten plate girders spaced 8ft. apart in each span, together with other steelwork, were supplied by the Motherwell Bridge and Engineering Company, Ltd., and the erection was carried out under the direction of Messrs. Formans and McCall. A similar structure was opened at Wakefield on June 1st. It is 327ft. 6in. between abutments, and carries a road over the river Calder, replacing the fourteenth-century "Chantry" bridge. It is good to learn that the latter, though now closed to vehicular traffic, is scheduled as an ancient monument, and will be preserved. Sir E. Owen Williams, in association with Mr. Maxwell Ayrton and Mr. L. Ives, the city surveyor, designed the bridge, and the contractors were the Norwest Construction Company, Ltd., of Liverpool.

The Tees Bridge.

Throughout the whole of the British Isles only one bridge of any magnitude is approaching completion. This, the first vertical lift bridge to be built in this country, is the new Tees bridge at Middlesbrough, and is being built by Dorman, Long and Co., Ltd. It is expected that it will be opened for traffic on February 28th this year. The bridge contains 6500 tons of steel and the lifting span provides a passage for shipping 250ft. wide with a clear headroom of 120ft. In its lowered position the headroom is 21ft. A roadway, 38ft. wide, is carried by the deck and two footways, each 9ft. wide, are cantilevered out from it. The length of the deck is 265ft. Included in the contract are ten approach bridges, five on each side of the river, and in this connection it is interesting to note that the bridge over the Billingham Dock

branch line on the Durham side consists of five spans, all of which have been constructed by means of electric welding instead of riveting. A fine picture of the bridge in its present state is reproduced in a Supplement to this issue. The consulting engineers for the bridge are Messrs. Mott, Hay and Anderson.

London Bridges.

In the South of England the three most important bridges to be completed were those over the Thames at Twickenham, Hampton Court, and Chiswick, all of which were formally declared open by the Prince of Wales on July 3rd. All three are road bridges, those at Twickenham and Chiswick carrying a new arterial road, while the other replaces an earlier iron structure which was quite incapable of carrying all the traffic using the Hampton Court–Esher road. A photograph of the Twickenham bridge is reproduced in the Supplement.

When the year 1933 opened, the London County Council was still awaiting the pronouncements of the Government as to the steps to be taken with regard to Waterloo Bridge, since in the late summer of 1932 a scheme for rebuilding the bridge had been rejected by Parliament. On January 24th Sir Percy Simmons read a letter received from the Ministry of Transport, before the Improvements Committee of the London County Council. Therein it was stated that His Majesty's Government had come to the conclusion that the bridge should be reconditioned, and widened by corbelling out the roadway to take four lines of traffic, at a cost of about £685,000, towards which a grant of 60 per cent. would be made. It was also suggested that the advice of the Royal Fine Arts Commission should be taken upon the design of the corbelling. A fortnight later the Improvements Committee reported its decision reluctantly to recommend the Government scheme, although, in the view of the Committee, a new bridge to carry six lines of traffic would be a better proposition. Thus was the major controversy over the bridges of London stilled, although murmurs of criticism of the proposal are yet to be heard. During the following months examination was carried out to discover exactly what it would be necessary to do in order to make the reconstructed bridge safe to carry a greater load of vehicles, and in October information was published in anticipation of tenders to be invited later. Piers Nos. 2, 3, 4, and 7, reckoning from the north abutment, are to be underpinned, and piers Nos. 5 and 6, together with arches Nos. 5, 6, and 7, are to be taken down and rebuilt. All the piers except Nos. 1 and 8, which are embedded in the Victoria Embankment and the Lambeth shore respectively, are to be given an effective bearing area of not less than 3000 square feet at a level not less than 35ft. below Ordnance Datum. Although the scheme is to follow the general lines of the plans prepared by Messrs. Rendel, Palmer and Tritton, tenderers, it is understood, are to have freedom of action. Up to the date of writing tenders have not been applied for, but we understand that action will be taken in a few days.

Chelsea Bridge also came under discussion during the year, and the original scheme of rebuilding was abandoned in favour of a plan of reconstruction. On November 7th the Improvements Committee of the London County Council recommended that it should be widened to take four lines of traffic, at a cost of £480,000, of which 60 per cent. would be provided by the Ministry of Transport. When so reconstructed, it will have a 40ft. carriageway and two 12ft. pathways.

Conclusion.

Any comparison between the years 1932 and 1933 in the sphere of bridge construction with the object of demonstrating an improvement in the outlook is probably inadmissible, owing to the fact that the majority of the bridges completed last year must have been put in hand either before the depression had reached its depth or before the signs of recovery had become apparent. Nevertheless, the fact remains that while during 1932 we could find no more than three bridges outside this country sufficiently noteworthy to merit a full description, during last year a substantially greater number was described in our pages. We can but hope that whether sound or not, the comparison truly shows that an improvement in the position is taking place, and that in the ensuing year structural engineers will benefit by a substantial increase in the number of orders recorded in their books.

Water Supply & Sanitary Engineering in 1933

No. I.

TO a greater extent perhaps than any other works of public importance, schemes of water supply and sanitary engineering have been held up by the financial position. When it is remembered how extraordinarily dry the year 1933 was from beginning to end, it is a great tribute to work carried out in earlier, more prosperous years that there has, on the whole, with the exception of a few country districts, been little suffering from shortage of water. Nevertheless, as the New Year opens water supply engineers in many parts of the country will be anxiously awaiting a period of heavy rainfall which will fill depleted reservoirs and revive failing springs. An exceptionally dry winter might render the summer position precarious in several districts. Although the amount of work carried out during the year was severely curtailed by the effects of the depression, some important schemes are being put through, as the following notes on the activities in various parts of the country will show.

London.

Taking London first, as being the most important district in the country, we are indebted to the Metropolitan Water Board for the following information as to its activities.

Hampton Pumping Station.—The work of replacing the three old Cornish "Bull" engines is now completed, and the new machinery was inaugurated on May 31st by Mr. Henry Ward, M. Inst. C.E., J.P., a member of the Board. The new machinery consists of a 500-kilowatt oil engine driven generator, driving two centrifugal pumps, together capable of pumping 12 million gallons of unfiltered water per twenty-four hours to the high-level filters, and one centrifugal pump to deliver alternatively in series 5 million gallons of filtered water per twenty-four hours against a head of 300ft. or in parallel 10 million gallons per twenty-four hours against a head of 150ft. Details of this machinery were given in THE ENGINEER of January 6th, 1933.

Kempton Park Pumping Station.—The two steam turbine-driven pumps of a total water horse-power of 2016, as described in THE ENGINEER of January 6th, 1933, have now been installed and are pumping into supply.

Fortis Green Pumping Station.—This station is being extended and four sets of oil engine driven centrifugal pumps will be installed for the supply to the Southgate and Hornsey-lane areas of the northern district. Each unit will be capable of pumping in series 2 million gallons per twenty-four hours against a head of 260ft., or in parallel 4 million gallons per twenty-four hours against a head of 130ft. The contract for machinery has been let to W. H. Allen, Sons and Co., Ltd., of Bedford, and that for the buildings to William Moss and Sons, Ltd.

Supply from Lee Valley.—The Board's Lee Valley reservoirs form a continuous chain through which the whole of the water for the filter beds at the Lee Bridge works must gravitate. This method of working has distinct disadvantages when algal growths are prevalent in one or more of the reservoirs. The Board has approved the construction of a 7ft. internal diameter reinforced concrete conduit from the Chingford intake to the northern end of the Copper Mill stream at Ferry-lane, and a 5ft. internal diameter cast iron conduit from the southern end of the Copper Mill stream to the aqueduct leading to the Lee Bridge works. These conduits will enable water from the reservoirs higher up the valley, viz., King George, Banbury, and Lockwood, to be passed to the Lee Bridge works without circulation through the lower reservoirs, as well as permitting water drawn direct from the river Lee to be supplied to the filter beds, if and when it is of sufficiently good quality, or when the reservoirs are badly affected by algal growths. The reinforced concrete conduit also acts as a much-needed duplication of an existing aqueduct and two brick culverts between the Chingford intake and the High Maynard reservoir. The work is being executed by Sir Robert McAlpine and Sons (London), Ltd.

Supply from New River: Green-lanes Works.—In order to overcome the very serious loss of output experienced in recent years from this station in consequence of algal growths in the raw water, and also to increase the maximum output to meet the growing demands, the Board decided to install primary rapid gravity filters capable of dealing with 32 million gallons per day. The constructional work is being executed by W. and C. French, Ltd., and the primary filtration apparatus is being supplied and fixed by the Paterson Engineering Company, Ltd.

Surbiton Pumping Station.—The second portion of the new machinery, consisting of low-lift pumps for raising filtered water from the low-level beds to the suctions of the high-lift engines, and unfiltered water from the low-level to the high-level reservoirs, has now been installed. A full description of these works appeared in the issues of THE ENGINEER of October 28th, page 428, and of November 4th, page 552, 1932.

Walton Pumping Station.—The steam turbine driven centrifugal pumps and electric generator, for raising water from the river Thames into the Molesey, Walton, or Island Barn reservoirs, and to meet additional electric current demands, have now been installed and set to work. This unit, capable of pumping 9 or 18 million gallons per day, was described in the issue of THE ENGINEER for January 6th, 1933.

Brixton Pumping Station.—The work in connection with the remodelling of these works, referred to in our issue of January 6th, 1933, is completed. The oil engine driven centrifugal pumps, six in number, each capable of pumping in series 1¾ million gallons per twenty-four hours against a head of 400ft., or in parallel 3½ million gallons per twenty-four hours against a head of 200ft., have been set to work, and are now pumping into the reservoirs at Norwood, Selhurst, Streatham, Rock Hill, Forest Hill, and the Crystal Palace tank supplied from this station.

A considerable amount of work was carried out during the year in connection with flood relief and sewage disposal problems in London.

Main Drainage Pumping Stations and Outfalls.—The reorganisation of the Abbey Mills pumping station has been completed by the substitution of four more electrically driven centrifugal pumps, each of 125 tons per minute capacity, for old beam engine sets, bringing the total capacity of the station up to 2100 tons per minute. At the Isle of Dogs, works undertaken for the relief of flooding included the installation of additional pumping plant at the pumping station and the construction of a 6ft. 6in. diameter supply culvert. Two additional centrifugal pumps driven by gas engines have been installed, and the capacity of the station is now 300 tons per minute. Work in hand at the southern outfall works, Crossness, entails the reorganisation of the machinery of the purification plant and the installation of oil-driven generators. A number of steam pumps are being replaced by oil and electrically driven centrifugal pumps.

Flood Relief Works.—For relieving the local sewers a branch of the Holloway storm relief sewer, 4ft. by 2ft. 8in. and 4ft. diameter, between Howard-road, Stoke Newington, and Mildmay-road, Islington, has been constructed and was brought into use during the summer. The construction of the Plumstead branch of the southern high-level sewer No. 2, for the relief of flooding and the diversion of the drainage of the higher parts of Plumstead into the high-level sewers, is approaching completion. The branch sewer is 6ft. and 5ft. 6in. diameter and 5ft. 3in. by 3ft. 6in., of a total length of about 1 mile. Branches of the southern low-level sewer No. 2 in Lavender-hill and Gaskell-street, Battersea, 4ft. diameter and 4ft. by 2ft. 8in. respectively, to relieve flooding in Battersea, are making good progress. For the improvement of the drainage of Wandsworth, the enlargement of the Wandle sewer in Garrett-lane has been commenced. The new sewer is 5ft. diameter. An extension of the Lewisham branch sewer, 5ft. 6in. diameter, from Southend-lane to Sydenham-road, is under construction, and similar work has been in hand for nine months on the Pentonville-road branch of the Fleet storm relief sewer in Caledonian-road, 6ft. diameter, from Wynford-road to Pentonville-road. The reconstruction of the Eastern Counties sewer between Coborn-road and Mostyn-road, 5ft. by 3ft. 4in. and 5ft. diameter, and the filling in of the old sewer under the London and North-Eastern Railway has been finished. In connection with the river Lee improvement scheme, the extension by two additional spans of the bridge carrying the four northern outfall sewers, 9ft. by 9ft., over the waterworks river, necessitated by the widening of the waterway, has been begun by the West Ham and River Lee Joint Committee. In addition, a number of important repair and maintenance works have, as usual, been carried out during the year.

West Middlesex Sewage Scheme.

The most important work in the sphere of sanitary engineering around London is undoubtedly the great West Middlesex sewage scheme, which we described fully in our issue of March 17th, 1933. It will be remembered that, broadly speaking, a large, rapidly developing area on the north-west of London and outside its boundaries, lying in the quadrant between the Thames and the Lee, is affected by this scheme. Work is proceeding rapidly and satisfactorily. About 45 miles of sewers are already laid, so that in this sphere about two-thirds of the work is already done. An excellent start has been made with the constructional and excavation operations on the disposal works at Mogden, the storm water tanks, for instance, being rather less than quarter finished. Work has been begun at the outfall at Isleworth Eyot, and at Perry Oaks a beginning has been made on the sludge disposal works site. The consulting engineers to this scheme, to whom we are indebted for the above information, are Messrs. Dodd and Watson, of Westminster.

Various Works.

Before referring in greater detail to the works of considerable interest or importance that have been carried out in various parts of the country, the progress of several other schemes may be mentioned. In Belfast, other than the extension of suburban piping, the most interesting feature is the installation of electrically driven pumping plant, affording a water supply of 60,000 gallons per day to the town of Ballynahinch from the Mourne Conduit. During the last few years we have referred on several occasions to the Esholt sewage disposal works of the City of

Bradford. These works were officially inaugurated in 1932, but it was not until 1933 that the whole of the sewage of the city began to be treated there. It is satisfactory to learn that although, owing to the large amount of business now being done in the wool trade, and the continued period of dry weather, the crude sewage is of abnormal strength, the final effluents discharged are of excellent quality, the Royal Commission test being well below 2 parts per 100,000. Moreover, the waters of the lake invariably contain sufficient dissolved oxygen for the support of fish and plant life. The amount of wool grease and 80 per cent. sludge collected in the precipitation tanks by acid precipitation taxes to the utmost the capacity of the pressing plant. The county borough of Burnley has for some time been busily engaged with the preparation of a scheme for reconstructing the sewerage system of the northern and eastern part of the borough at an estimated cost of £71,000, and plans and estimates have been submitted to the Ministry of Health, with an application for loan sanction. Under the Coventry (1928) Act, Coventry is proceeding with investigation works and the development of well sites. By the kindness of James Mansergh and Sons, of Victoria-street, Westminster, we are informed that good progress is being made with the work at the Derby sewerage works, the alterations to the Alvaston storm overflow chamber and the laying of a 48in. diameter relief sewer from this chamber to the disposal works having been completed. By the end of next April it is hoped that the improvements now being carried under the River Derwent Improvement Scheme will be completed. With regard to the Langthwaite reservoir of the Lancaster water supply scheme, the core wall to the main embankment has been built and the bank formed to within about 12ft. of the top. The cut-off trench round the reservoir is filled with concrete, and the work of beaching and pitching the bottom and sides of the reservoir is in hand. During 1933 there was completed and brought into use by the water department of the City of Edinburgh a second pipe line, 5 miles long, partly 33in. and partly 22in. in diameter, for conveying the water from the Moorfoot works into the city. By the courtesy of W. H. Radford and Son, chartered civil engineers, of Nottingham, we are enabled to give the following details of various works. The Ilford and Barking Joint Sewerage Committee has seen during 1933 the completion of a large pumping station for pumping the sewage of the two boroughs into the London northern outfall, and large storm tanks to deal with storm water, which will discharge into the river Roding. Work upon an outfall sewer and several branch sewers, bringing to completion the sewage scheme of the Borough of Wrexham, together with detritus channels, upward flow settlement tanks, and biological filter beds, was carried out during the year.

At Leeds the contract for the construction of a sludge press house, together with the required machinery, has been let. A gravitation trunk sewer, about 3½ miles long, mainly in tunnel, now under construction at Nottingham by the contractors, Harold Arnold and Son, Ltd., of Doncaster, is expected to be completed towards the end of 1934. A new outfall sewer in tunnel has also been constructed and screening chambers and sludge pumping plant are being installed at the sewage disposal works. On the Oxford waterworks extension, the construction of the intake works, pumping station, sedimentation tanks, filters, and rising main, is nearing completion, and some 5½ miles of 27in., 20in., and 18in. pipe lines for distribution of the water from the Beacon Hill covered service reservoir have been laid. The engineers to these works are Sir Alexander Binnie, Son and Deacon. Preston reports that about 10 miles of water supply pipes had been laid up to the end of 1933, and that a gravitation tunnel, 1000 yards in length, is now being driven through the sandstones under Longridge Fell for the purpose of conveying the water from the pipe line into the Spade Mill reservoir. An interesting detail in this district is the installation at the main intake at Langden in the Forest of Bouland of an exceptionally large Venturi flume for the purpose of recording the very high floods received from this watershed. The flume has a maximum registration at the rate of 1000 million gallons a day. The new Woodhouse Mill sewage disposal works, which provide for a daily dry-weather flow of 500,000 gallons and replace several smaller works of antiquated types, were completed by the Sewage Disposal Department of the City of Sheffield.

As noted in an illustrated article which appeared in our issue of September 22nd, the Ryburn dam, which constitutes the second instalment of the Ryburn Valley scheme for the supply of water to the City of Wakefield, was completed, and the reservoir so formed was opened on September 7th. The construction of the Baitings dam, which will form the third instalment of the scheme, has been postponed, as, owing to trade depression, the consumption of water in the city and district has not increased. Meanwhile, water is being taken for supply purposes from a temporary intake higher upstream. A view of the Ryburn dam nearing completion is the subject of an engraving in one of the Supplements accompanying this issue.

In our issue of December 15th, we described and illustrated the extensions to the sewerage works of the Wandle Valley Joint Sewerage Board, which were opened on December 9th. The extensions provide for the treatment of an additional 2 million gallons per day of sewage. Mention should also be made of the new works inaugurated on November 14th, at Wolverhampton, to deal with a dry-weather flow of 5 million gallons a day; 6 acres of rectangular bacteria beds were completed and brought into use during the year, and two sets of bar screens with automatically controlled valves have been installed, together with an electrically operated band conveyor for loading the screenings into a wagon.

Birmingham.

Improvement of the Rivers Tame and Rea.—Good progress was made with the improvement works on the above rivers which are being carried out under the extensive powers of the Birmingham Corporation (Rivers Improvement) Act, 1929. The whole of the works upon the river Tame from Coleshill to the junction of the river Rea, have been completed, with the exception of the removal of two railway bridges spanning an abandoned loop of the old river bed. The work has included the widening, deepening, and straightening of 5½ miles of the river. The improved section of the river has a width of 75ft. at the bed level, the banks being sloped to an angle of 45 deg., and reveted with lump slag bedded in concrete. Flood banks have been constructed to prevent the flooding of adjacent lands during periods of maximum discharge. On certain sections of the river, where land was not available for the construction of sloping sides and flood banks, heavy brick and concrete retaining walls have been provided. The improved river channel has a discharging capacity of approximately half a million cubic feet per minute, which allows ample margin for the further urbanisation of the catchment area. The work has been carried out in three contracts, the contractors for the first and third contracts being Tarmac, Ltd., Wolverhampton, and those for the second Cameron and Pooley, Ltd., Birmingham.

Birmingham, Meriden and Solihull Joint Sewerage.—These sewerage works are designed to deal with the drainage from approximately 15,000 acres, 5014 acres of which lie within the City of Birmingham, and the remainder within the adjacent districts of Meriden and Solihull. The main valley sewer has a length of 12,500 yards, and varies in diameter from 66in. to 33in. The branch sewers have a total length of 6 miles of diameters varying from 36in. to 9in. An interesting feature of the scheme is a reinforced concrete aqueduct 366 yards in length, terminating in a syphon under the river Cole, 450ft. in length, constructed with 48in. diameter cast iron pipes. The aqueduct consists of eighteen reinforced concrete arches, with spans of 20ft. 6in. and two larger arches with a span of 42ft. The work is being carried out as an unemployment relief works, the contractors being Messrs. Bolton and Lakin, Birmingham. It is anticipated that the scheme will be completed early this year.

Glasgow.

Under the Act of 1885 the Corporation of Glasgow was authorised to construct a second tunnel from Loch Katrine to Milngavie, to augment the water supply to the city. This tunnel was designed and constructed with a carrying capacity of 70 million gallons per day. Through the Endrick and Blane valleys, where the water is carried in pipes, it would require four pipes, each of 48in. diameter, to carry this quantity, but as the city's need for many years was not likely to reach this demand, only two of these 48in. mains were originally laid. About four years ago it became apparent that the margin of safety had been reached, and that provision should be made for further requirements, and it was then decided that a third pipe should be laid through these two valleys, bringing the carrying capacity of the pipes up to 75 per cent. of the total capacity of the tunnel. The remaining 25 per cent. will remain for future consideration when circumstances dictate the necessity for it.

The work was begun in April, 1931, and has been carried on continuously till its completion recently. The length of new 48in. main laid in the two valleys amounts to over 3 miles. The estimated cost was £85,000.

(To be continued.)

LAUNCHES AND TRIAL TRIPS.

ALMKERK, twin-screw motor ship; built by the Netherland Shipbuilding Company, to the order of the Holland-Australian Line, The Hague; dimensions, 493ft. by 60ft. by 40ft. 10in.; to carry passengers and cargo. Oil engines of Stork-A.E.G.-Hesselman type; constructed by Gebrs, Stork and Co. N.V., of Hengelo; launch, December 16th.

STEEL BARGE; built by Henry Scarr, Ltd., Hessle, near Hull; dimensions, 75ft. 6in. by 14ft. 9in. by 7ft.; to carry coal on Yorkshire waterways; launch, December 19th.

DUNDEE, steamship; built by Caledon Shipbuilding and Engineering Company, Ltd.; to the order of the Dundee, Perth and London Shipping Company, Ltd.; dimensions, 281ft. by 42ft. by 17ft.; to carry cargo and oil in bulk. Steam engines, triple compound type; constructed by Alexander Stephen and Sons, Ltd.; launch, December 28th.

PORT CHALMERS, twin-screw motor ship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Commonwealth and Dominion Line, Ltd., of London; dimensions, 486½ft. by 64ft. 3in.; to carry passengers and cargo. Oil engines of Barclay, Curle-Doxford type; constructed by Barclay, Curle and Co., Ltd.; trial trip, December 28th.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

JOSEPH KAYE AND SONS, Ltd., Lock Works, Leeds, 10, have just received an order for 500 corrugated oil bottles from the Cordoba Railway Company.

THE ENGLISH ELECTRIC COMPANY has received a contract for the following three turbo-alternator sets in connection with the large extensions which are now being made to Messrs. Edward Lloyd's Kemsley paper mill:—A 15,000 kW, two-cylinder, 3000 r.p.m., three pass-out turbine, believed to be the largest machine of this type yet to be constructed in this country. It will drive an alternator and supply process steam up to 240,000 lb. of steam per hour at a pressure of 20–30 lb. per square inch gauge, to the largest newsprint machine in course of construction. The alternator will generate power at 6600 volts, 50 cycles, three-phase. A 5000 kW pass-out single-cylinder turbine for 3000 r.p.m., to pass-out up to 150,000 lb. of steam per hour, at a pressure of 20–30 lb. per square inch gauge, with an alternator for 6600 volts, 50 cycles, three-phase; and a 750 kW single-cylinder geared house set, running at 7000 r.p.m., the alternator being geared down to 1500 r.p.m. and generating power at 430 volts, 50 cycles, three-phase.

CALENDARS, DIARIES, &c.

AVONSIDE ENGINE COMPANY, Ltd., Bristol.—Wall calendar with monthly tear-off sheets.

COUNTY OF LONDON ELECTRIC SUPPLY COMPANY, Ltd., County House, New Broad-street, E.C.2.—Greeting telephone card.

CRAVEN BROTHERS (MANCHESTER), Ltd., Reddish, Stockport.—Wall calendar.

DEXINE, Ltd., Abbey-lane, Stratford, E.15.—Wall calendar.

FLOWERDEW AND CO., Ltd., 227–228, Strand, W.C.2.—Wall calendar.

G. AND T. EARLE, Ltd., Wilmington, Hull.—Wall calendar, 1934–1936, with monthly tear-off sheets.

B. T. KING, 146A, Queen Victoria-street, E.C.4.—Pocket diary.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., Electra House, Victoria Embankment, W.C.2.—Greeting card.

MIDGLEY AND SUTCLIFFE, Bradford.—Wall calendar.

NEW SOUTH WALES RAILWAYS.—Greeting card from the Commissioner and Executive Officers.

RICHARDSONS, WESTGARTH-BROWN, BOVERI, Ltd., 56, Victoria-street, S.W.1.—Wall calendar with monthly tear-off sheets.

W. H. WILLCOX AND CO., Ltd., Southwark-street, S.E.1.—Wall calendar with montly tear-off sheets.

EDWARD WOOD AND CO., Ltd., Ocean Ironworks, Manchester.—Diary and wall calendar.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MESSRS. MERZ AND MCLELLAN announce that Mr. Richard W. Gregory has resigned from partnership in the firm, but is retained in an advisory capacity.

THE SKEFKO BALL BEARING COMPANY, Ltd., has opened a new stocks and service depôt at 31, Mosley-street, Newcastle-on-Tyne, 1. Mr. J. E. Potts is the company's local representative.

GEORGE SALTER AND CO., Ltd., West Bromwich, inform us that they have opened a branch office at the *Chronicle* Buildings, Corporation-street, Manchester, where Mr. Albert Tonks, who has acted for the firm in the district for over twenty years, will be the chief representative.

CATALOGUES.

INCANDESCENT HEAT COMPANY, Ltd., Cornwall-road, Smethwick, Birmingham.—A booklet showing the range of the firm's products.

BUTTERWORTH BROTHERS, Ltd., Newton Heath Glass Works, Manchester.—A catalogue of illuminating and industrial glassware.

SELAS GAS AND ENGINEERING COMPANY, Ltd., City-road, Manchester, 15.—Catalogue pages of burners, metal baths, gas furnaces, &c.

VISCO ENGINEERING COMPANY, Ltd., Stafford-road, Croydon, Surrey.—Publication No. 333 of dust-collecting units for dry grinding machines.

BRITISH HEATING INDUSTRIES, Ltd., Beehive Works, Bolton, Lancs.—A catalogue describing the "Heatrite" system of air control for boilers.

DAVID BROWN AND SONS (HUDDERSFIELD), Ltd., Huddersfield.—A brochure giving particulars of the design and making of spiral bevel gears.

UNITED WATER SOFTENERS, Ltd., Permutit House, Gunnersbury-avenue, W.4.—A comprehensive treatise on the conditioning of boiler feed water.

C. A. PARSONS AND CO., Ltd., Heaton Works, Newcastle-on-Tyne, 6.—Leaflets on the firm's iron and brassfoundry products and welded steel structures.

BELL BROS. (MANCHESTER, 1927), Ltd., Denton, near Manchester.—A 127-page book dealing in detail with installations of Bell's water purification plants.

BABCOCK AND WILLCOX, Ltd., Babcock House, Farringdon-street, E.C.4.—Catalogue 1131 on marine stokers; publication No. 939B on the "Fuller Bonnot" mill.

RUSTON AND HORNSBY, Ltd., Lincoln.—A booklet describing the range of the Ruston Lister Marine Company's, Ltd., range of marine fuel oil engines from 32 to 106 B.H.P.

STAFF MAGAZINES.—The Industrial Welfare Society has arranged to hold the twelfth annual Conference for Editors of Works and Staff Magazines on February 16th, 1934, in London. The Conference will open with luncheon, at which Sir Robert Waley Cohen, K.B.E., will be the guest. Two papers will be read during the afternoon, and will be followed by discussion. Whilst the Society is in touch with about 250 of these journals, it is anxious to bring this Conference to the notice of all firms publishing such magazines. Further details may be had from the Secretary, 51, Palace-street, S.W.1.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Anglo-Continental Steel Discussions.

Considerable interest has been aroused by reports of negotiations proceeding between the British steel makers and the Continental Steel Cartel, with the object of coming to an agreement regarding price-cutting in certain markets. For some time a section of the British steelmakers has advocated a policy of market arrangements with their competitors, but until recently the industry has not been in a sufficiently strong position to enter into discussions with any prospect of success. Since the imposition of the import duties, however, a firmer attitude has been possible with regard to export business, and tentative approaches have been made by the steel makers on both sides. Neither the British nor the Continental industries have been sufficiently organised to enter into arrangements embracing a wide range of steel products. The ship plate manufacturers, however, have been discussing the question of the Scandinavian market with their Continental competitors for some time, and, according to reports, an agreement has been practically reached. So far, the Scandinavian shipbuilders have benefited at the expense of the British yards by being able to play off the Continental ship plate makers against the British, with the result that during the past few months competition of a very intensive character has developed. Reports are current of the British steel works having quoted down to £6 5s. c.i.f., and of French works going to the ridiculous lengths of asking £5 12s. 6d. paper, c.i.f., for plates of Siemens Martin quality. It is, of course, in the interests of the Continental as well as of the British steel makers to reach an arrangement which would put an end to this price-cutting, and the British shipyards should also benefit by being relieved of the uneconomic competition of Scandinavian builders.

The Pig Iron Market.

It is unlikely that any change will occur in the conditions ruling in the pig iron market until the middle of January. For the time being buyers and sellers alike will mark time, as not only is stocktaking proceeding at most works, but there is usually an inclination at this time of the year to wait until it is possible to estimate the way business will develop. It is a satisfactory feature of the position that whilst users are well covered forward, the producers are not pressing for new business, as they have good order books, and specifications against contracts are reaching them with regularity. On the North-East Coast the stringency which has existed for some weeks will be only partially relieved by the accumulation of iron manufactured during the holidays and the addition to the make of the output of another furnace which is to be lighted at Skinningrove shortly. Many consumers have been forced to supplement their supplies of Cleveland iron with large purchases of Midland brands. Anticipations that the production on the North-East Coast would be considerably increased in the New Year have been damped by statements that the difficulty of ensuring adequate supplies of coke may cause delay. The Midland light casting industry closed down for a much shorter period than is customary, and there was little relaxation in the pressure upon the pig iron producers for deliveries. As stocks of pig iron still exist in the Midland makers' yards, this was a welcome development. New business in Derbyshire and Northamptonshire brands has been limited to a few odd parcels, and it is unlikely that any pronounced buying movement will occur for some time, as the big users have covered their requirements in some cases until the end of June. In Scotland the consuming works have been idle, owing to the New Year holidays, and the production of pig iron has gone into stock. Scottish producers are not so well off as regards forward bookings as the English, and there is room for a considerable expansion in this department during the coming months. The demand for hematite iron has been insignificant this week, owing to the holiday conditions, but the market position is sound, and before the holidays the demand was in excess of production. North-East Coast makers are disinclined to sell anything but small lots, and although merchants hold contracts they are not anxious to sell forward, as they expect an advance in prices shortly. Consumers, on the other hand, are reported to have offered contracts covering the whole of 1934.

The North-East Coast and Yorkshire.

The finished steel departments on the North-East Coast are starting the year under satisfactory conditions, and in several instances worked without a break through the holidays. An encouraging feature of the market has been the slow but steady increase in export business, and over the Christmas holidays there has been a considerable volume of inquiry from overseas markets. The depression in the shipbuilding industry severely affected the demand for steel during 1933, but the outlook has improved of late and the orders for naval and commercial shipping now held by Tyne firms will shortly be reflected in large orders for shipbuilding steel. The railway programmes also will provide a considerable tonnage of work for the mills on this coast. In fact, the works producing rails have been well employed for some time. In Yorkshire, most firms resumed work after only a short holiday break. Nearly all departments are entering the New Year in a satisfactory position. The demand for steel strip continues to be a feature of the market, although a fair tonnage of Continental material is being imported at £7 5s. to £7 15s., against £8 5s. to £9 asked for British material. Business in bright drawn bars has been less active of late, but there has been no decline in the demand for small steel bars which is keeping the re-rolling works busy. The engineering industries are commencing the year with fair orders in hand, and with prospects of considerably improving their position during the coming quarter.

The Midlands and South Wales.

Interesting comparisons between the state of the iron and steel trades in the Midlands in January, 1933, and at the beginning of 1934 can be made. The industry in this district was beginning to stir from the depression which had affected it for so long, but there were still elements in the situation which did not help to restore confidence. Prices of uncontrolled steel materials were at a low level, and the quotation for imported Continental bars was £5 15s. d/d, against which the English re-rollers quoted £6 10s. to £7 for small steel bars. Few of the English works were even moderately busy, and there was a general tendency on the part of consumers to wait and see how the Continental situation developed. When it became apparent, however, that the European Steel Cartel was intent upon forcing up prices, there was a concerted movement amongst consumers to cover forward requirements, and this started a phase of activity which has lasted throughout the year and has become accentuated in the later months. The price of re-rolled steel bars has advanced to £7 5s. to £7 10s. for home delivery and the Continental quotation has risen to £6 10s. 6d. d/d, including duty. The lighter trades in the Midlands in particular will enter 1934 with sufficient orders on their books to keep them well employed for many weeks to come, whilst the steel works have good contracts in hand, resulting from the recent orders from the railways, as well as from the expansion in general trade. The structural steel makers who a year ago were complaining of bad trade, although they are not fully employed, are making steady progress. Competition for any work in sight, however, is said to be particularly keen in this branch of the industry. The price of uncontrolled British steel descriptions shows a tendency to advance, in spite of the fact that of late rather more orders have been placed for Continental steel. In South Wales the situation perhaps has not improved during 1933 to the same extent as in some other departments. This is because the export of tin-plates decreased during the later months of the year, and also because the industry has had to meet keen competition from the American and German makers.

Ferro-alloys.

A moderate amount of activity has ruled in the ferro-alloys market, and expectations are rife that prices for several alloys will be advanced in the near future. For the most part business has been limited to small tonnages, but in the aggregate these have reached a respectable total. Consumers have bought ferro-silicon on a fair scale lately in order to forestall a possible increase in prices in the New Year. Business in ferro-chrome has been restricted since the prices were increased a few weeks ago. This movement followed the price agreement reached amongst the makers, but previously there had been some brisk covering by consumers. Stringent conditions rule in the market for ferro-tungsten and tungsten metal powder owing to the difficulties of securing adequate supplies of ore, and business in these alloys for the past week or two has been almost stagnant. There has been no fresh advance in prices, but it is expected that if the ore situation does not become easier quotations will be increased. Prices of ferro-manganese also show a tendency to become firmer; but, on the other hand, there has been a decline in the demand for cobalt, which reflects the slackening in business in steel used in the manufacture of permanent magnets. Business in ferro-vanadium has improved slightly and there has also been more interest shown in ferro-molybdenum during the past week or two. Amongst other alloys which are showing a firmer tendency are metallic manganese at 1s. 2d. per pound, ferro-titanium at 9d. per pound, and ferro-phosphorus at £14 10s. per ton.

Trade with India in 1933.

The "Survey of the Import Trade of India" from April 1st to September 30th, issued by the Department of Overseas Trade, shows that, although the total imports were reduced from Rs. 71 crores to Rs. 55½ crores, and the British share from Rs. 25½ crores to Rs. 23 crores, the percentage of the reduced trade obtained by the United Kingdom rose from 35·7 to 41·1. The advantageous effects of the Ottawa preferences are becoming apparent, and it is noteworthy that British importers improved their percentage of the trade in almost every item in which there was preference. Although the imports of steel bars fell from 43,894 tons to 27,449 tons, Great Britain's share increased from 5852 tons to 7012 tons. On the other hand, Belgian shipments slumped from 20,904 tons to 11,955 tons. Imports from Luxemburg declined from 11,863 tons to 5000 tons, and from France from 3093 tons to 2694 tons. There was little reduction in the trade in beams, channels, pillars, girders and bridge work. The imports fell from 9521 tons to 9346 tons, of which the British share was 5207 tons, compared with 3148 tons a year ago; but Belgian imports declined from 3840 tons to 2288 tons. There was an expansion in the trade in rails, chairs and fish-plates, although it was much below normal, from 945 tons to 1695 tons. Practically the whole of the imports of this material were from the United Kingdom. The imports of machinery and mill work rose from Rs. 571½ lakhs to 655¾ lakhs, in consequence of largely increased imports of sugar machinery, boilers and prime movers, which more than offset a decline in electrical and mining machinery. Imports from the United Kingdom were Rs. 460½ lakhs, compared with Rs. 442¼ lakhs. As orders for sugar machinery were not placed with British manufacturers until late in the season, these imports will probably continue during the third quarter of the year, when imports from Continental competitors have ceased.

Copper and Tin.

The market for electrolytic copper has been under holiday influences this week, and only a limited business has been transacted. There seems to be a general inclination to await the result of the consideration of the copper "code," which has been postponed until the middle of January. It is assumed that the "code" will eventually be adopted and that the American price will be fixed at 9c., but to compete with producers in other countries the American export price will probably have to be much lower. This week the quotation has been held at between 8·30c. and 8·40c., c.i.f., the sterling price having been steady at £36 5s. The demand from British consumers for electrolytic copper has been poor, but after the holidays German buying increased. Little interest has attached to business in the London standard copper market during the past week. Prices have been fairly steady and there has been a good undertone. The threatened shortage of prompt warrants did not develop to the extent which was at one time expected and the contango has remained at about 2s. 6d. In the middle of the week prices showed a tendency to advance on some rather brisk buying, but receded when this died down. . . . Conditions in the tin market have not altered since the holidays, and, whilst prices have been steady, comparatively little business has been transacted. This is not surprising, however, since the Continent rarely buys at this time of the year and American purchases also have been interrupted by the holidays. Speculation on the London standard market has been light for some time. According to Mr. W. H. Gartsen's statistics, the visible supply at the end of December declined by 2305 tons to 23,483 tons. The United States deliveries, however, which were expected to show an improvement upon last month's figures, were only 3130 tons, or about 200 tons lower. The carry-over in the East decreased by 391 tons, but at Arnheim the figure increased by 157 tons to 2311 tons. The steady improvement in the statistical position shown by the figures created a firm tone in the market, but so far this year consumers have regarded the situation with apathy.

Lead and Spelter.

A weak tone characterised the lead market in the opening days of the New Year, but it seems scarcely likely that there can be any pronounced decline from the present low levels. To some extent the easier conditions were due to the disappointing statistics issued in America. These showed that stocks of lead in the United States were 187,843 tons at the end of November, compared with 174,721 tons at the end of October. Another factor which has had a depressing effect has been the American Government's purchases of silver, which, it is thought, may lead to an increase in the production of lead ores which contain silver. Heavy stocks already exist, which show little tendency to decrease, and the possibility that production will be increased as a result of the demand for silver has exerted a discouraging influence upon the market . . . . The spelter market developed a rather weak tone at the commencement of the New Year, but as buying by consumers does not usually develop until after the New Year holidays this was not surprising. The general sentiment in this market, however, appears to have been little affected by the slight reactions experienced recently, and the tone continues good. Reports from the Continent indicate that the demand in the New Year has opened upon a considerable scale and that the German brass industries in particular have bought substantial quantities. In this country, however, although the brass trades are active, the galvanised sheet manufacturers are still working at a low rate and there seems little prospect of business from this quarter improving.

Average Metal Quotations.

The London Metal Exchange average quotations for December show a slight improvement over those for the preceding month. Up to and including November the average prices, with the exception of tin, had shown a decrease for four months. In December, however, the average price for cash copper was 14s. 5d., and the three months' price 4s. 2d. above the November figure; the average quotation for electrolytic copper showed an increase of 7s. 10d., and that for wire bars of 7s. 1d. There was also a rise in the tin average to 18s. 7d. for cash and £1 6s. 9d. for three months. The weakness in the lead price was one of the features of the metal markets during December, so that it is not surprising to find that the quotation, in spite of the low November figure, is 2s. 1d. down on "current month" shipment, 2s. 5d. on shipment the third following month, and 2s. 2d. on the mean average. The average quotation for spelter was slightly better at 4s. 5d. over the November average for the "current month" shipment, 5s. 9d. higher for the third following month shipment, and 5s. 1d. on the mean quotation. The following are the official average quotations for December:

STANDARD COPPER	Cash	£31	6 11½
	3 Months	£31	9 5½
	Settlement	£31	6 11½
ELECTROLYTIC COPPER		£34	14 2
ELECTROLYTIC WIRE BARS		£35	1 10
BEST SELECTED COPPER		£34	1 11
STANDARD TIN	Cash	£227	14 10
	3 Months	£227	15 7
	Settlement	£227	14 5
LEAD — For shipment the current month		£11	8 7
LEAD — For shipment the third following month		£11	13 1
LEAD — Mean		£11	10 10
LEAD — Settlement		£11	9 0
SPELTER — For shipment the current month		£14	16 6
SPELTER — For shipment the third following month		£15	1 2
SPELTER — Mean		£14	18 10
SPELTER — Settlement		£14	16 8

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Hematite Mixed Nos.	3 2 6	3 0 0
No. 1	3 3 0	3 0 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	3 5 0	—
MIDLANDS—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 6	—
Basic	3 10 0	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	3 6 0	—
N.W. COAST—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

(*Basic iron prices subject to a rebate of 5/–.*)

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
LANCS.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
MIDLANDS—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. COAST—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
LONDON AND THE SOUTH—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	7 10 0	—
Plates, ¼in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 7 6	8 5 0
NORTH-EAST COAST—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 7 6	6 10 0
Plates, ¼in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 2 6	8 5 0
Boiler Plates, ¼in.	8 5 0	7 12 6
MIDLANDS, AND LEEDS AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 10 0	6 10 0
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 2 6	8 5 0
Boiler Plates, ¼in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
GLASGOW AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 15 0	6 15 0
Plates, ¼in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
SOUTH WALES AREA—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 10 0	6 10 0
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 7 6	8 5 0

IRELAND—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 10 0	8 0 0
Plates, ¼in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	8 15 0	8 15 0
14-G. to 20-G., d/d	10 0 0	9 0 0
21-G. to 24-G., d/d	10 5 0	9 5 0
25-G. to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/3 to 16/6.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic, Soft (25·41% C.)	6 0 0
„ Medium (0·42% to 0·60% C.)	6 17 6
„ Hard (0·61% to 0·85% C.)	7 7 6
„ „ (0·86% to 0·99% C.)	8 7 6
„ „ (1% C. and up)	8 17 6
Soft (up to 25% C.), 500 tons and up	5 5 0
100 tons	5 12 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/9 per lb.	
Ferro Tungsten	2/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 12 6	7/–
„ „ 8 p.c. to 10 p.c.	£21 12 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 10 0	9/–
„ „ „ 1 p.c. carbon	£35 12 6	10/–
„ „ „ 0·70 p.c. carbon	£37 10 0	12/6
„ „ „ carbon free	10½d. per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 0 0 to 17 10 0 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METAL.

Official Prices, January 3rd.

COPPER—		
Cash	£32 2 6 to £32 3 9	
Three months	£32 5 0 to £32 6 3	
Electrolytic	£35 10 0 to £35 15 0	
Best Selected Ingots, d/d Birmingham	£36 0 0	
Sheets, Hot Rolled	£62 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10d.	10d.
„ Brazed (basis)	10d.	10d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
„ Brazed	11d.	11d.
TIN—		
Cash	£226 17 6 to £227 0 0	
Three months	£227 2 6 to £227 5 0	
LEAD:	£10 17 6 to £11 2 6	
SPELTER:	£14 7 6 to £14 15 0	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

LANARKSHIRE—		Export.
(f.o.b. Grangemouth)—Navigation Unscreened		13/– to 13/6
„ Glasgow—	Ell	13/– to 15/–
„ „	Splint	16/6
AYRSHIRE—		
(f.o.b. Ports)—Steam		13/–
FIFESHIRE—		
(f.o.b. Methil or Burntisland)—Steam		14/6 to 14/9
Unscreened Navigation		12/6 to 13/–
LOTHIANS—		
(f.o.b. Leith)—Hartley Prime		14/– to 14/6
Secondary Steam		13/6 to 13/9

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	17/6 to 20/6
Furnace Coke	13/– to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	14/6 to 15/–
„ Second	13/–
„ Best Small	10/6 to 11/–
Unscreened	12/– to 12/6
DURHAM—	
Best Gas	14/8
Foundry Coke	17/– to 19/–
SHEFFIELD—	Inland.
Best Hand-picked Branch	27/– to 28/–
South Yorkshire Best	22/– to 24/–
South Yorkshire Seconds	17/6 to 19/6
Rough Slacks	6/– to 9/–
Nutty Slacks	7/– to 8/6
Furnace Coke (at ovens)	12/3

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/–
Foundry Coke	21/– to 36/–
Furnace Coke	18/6 to 20/–
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm	9/6 to 10/6
Steam Coals:	
Large	18/– to 20/–
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ½d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Railway Disaster.

THE inquiry into the causes of the Lagny railway disaster is likely to be prolonged for a considerable time by the complex factors that have to be taken into account, and by the failure to form any opinion from evidence that should have been conclusive. It was expected that the Flament recorder on the Strasburg locomotive would have provided the required evidence by indicating whether the advance signal was at clear or at danger. It appears that the recorder slip actually showed the signal to be at clear, but it is also said to reveal anomalies which suggest that the apparatus was not working properly. If an automatic apparatus like the Flament recorder should fail, there is naturally a tendency to investigate every possibility of failure in the automatic signalling system as a whole, and while nothing can be said about the inquiry until the experts have issued their report, it is, nevertheless, clear that they are not satisfied with what has already been revealed. So far, the experts' investigation has led the Minister of Public Works to convene the directors of all the railway companies and to explain to them what was required in the way of general reorganisation. They are instructed to prepare for the Minister, early this month, plans for improving the signalling arrangements and carrying out works necessary to ensure absolute safety in railway travelling. Since the series of accidents years ago, involving the loss of many lives through the burning and smashing of wooden coaches, the construction of steel coaches has been continued mainly for long non-stop express trains, but this transformation of rolling stock has had to be carried on very prudently for financial reasons. The steel coaches now used are costly, though builders affirm that the prices and weights can be reduced to much below the generally accepted figures, without sacrificing solidity. The Lagny disaster has aroused a public demand for more steel coaches. The Government intends to do all it can to find means of providing credits, even at such a time as this, when it is already grappling with one of the most difficult financial situations yet experienced. There appears to be a danger of the railway companies being made the victims of a panic. Under Parliamentary control their hands were tied for many years, and little could be done to improve the railway service. Now that they have more liberty, and are raising the railway system to a high state of efficiency, their future may be imperilled if they are obliged to incur a crushingly heavy expenditure which may not be entirely justified.

Unemployed Engineers.

Directors of the State engineering schools have been interviewed with the idea of ascertaining their views upon the future of the profession, as judged by the growing difficulty experienced by students in finding situations at a time when industry and the State are providing less employment for them. All the directors declare that the situation is serious. Students from the Ecole Polytechnique are a privileged class, and are mainly absorbed in the army, while the remainder have always found occupation in State administrations and in industry, which kept the highest situations open to polytechnicians. The number of army officers is being reduced, the State departments have entered upon a period of retrenchment and economy, and in industry the first thing done in a time of crisis is to cut down expenditure on research and other work not immediately productive. A growing number of polytechnicians are, therefore, without employment, or are taking on work outside their profession. Students from other engineering schools are in a worse plight, and the long list of applications for work seems to justify the belief that engineers are suffering more from the crisis than operatives. The Association des Ingénieurs des Arts et Métiers, which has 15,200 members, is endeavouring to deal with the problem by widening the field of research for situations in industries that do not generally employ engineers, and could yet profitably utilise the services of men with their special qualifications. These efforts appear to be meeting with some success. In view of the precarious outlook, the schools have decided to reduce the number of students admitted. In five State schools the number of admissions in 1932 was 1110, and in the last session it was reduced by about 20 per cent. Normally, the number of students leaving schools with degrees far exceeds the situations available for them, and the difficulty now experienced in getting employment will, it is believed, deter parents from sending their boys to engineering schools, so that eventually the supply of engineers may be adjusted to the demand.

Franco-British Trade.

According to official announcements, the surtax of 15 per cent. on British goods was to have been suppressed on the first day of this month, and as the turnover tax is to be reduced from 6 per cent. to the normal 2 per cent. the outlook for importers in this country of British manufactures is distinctly hopeful. These trade facilities unfortunately coincide with a period of slackness, when there is little business to be done in engineering products. Special machine tools may sell more freely with the removal of the surtax, and in a general way British firms should be able to benefit from the failure of the Franco-German commercial treaty negotiations, which will have the effect of depriving German manufacturers of the privileged position which they have occupied in this market. The import quotas will necessarily restrict business in British goods, and any permanent effect which they may have will only be revealed after the signing of the Anglo-French treaty. It is obvious that the quota system and the new Tariff Bill now prepared will modify appreciably the possibilities of trade development between the two countries, unless the commercial treaty should provide for any such contingency. The uneasy feeling that has been aroused amongst French manufacturers by the removal of the surtax is only partly allayed by the promise that they will be adequately protected by import quotas.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

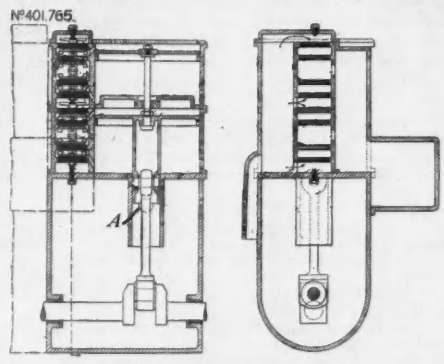
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

401,765. May 26th, 1932.—CHARGING OR SCAVENGING PUMPS FOR TWO-STROKE ENGINES, Sir K. I. Crossley and H. D. Carter, Openshaw, Manchester.

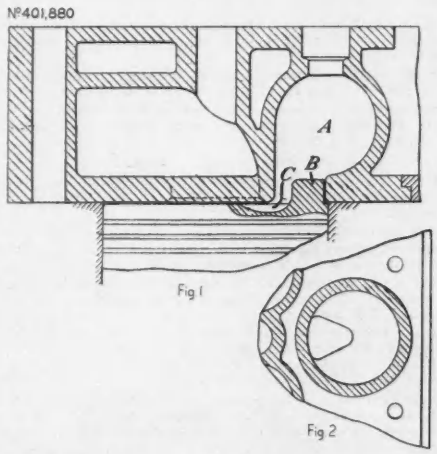
The principal object of the invention is to enable the charging pump to be constructed of minimum overall dimensions, and also to enable the dimensions of all revolving and reciprocating parts of the pump to be reduced and thereby to lessen the dynamic disturbances produced by the motion of such parts. Another object is to enable the crosshead pin and connecting-rod of the pump to be removed without dismantling the pump. The



inlet and outlet valves for the pump are also readily removable for inspection and replacement without breaking prepared joints. With these and other objects in view, the invention comprises the construction of a charging pump with two or more pistons working in tandem cylinders and operated by a single connecting-rod, the inlet and outlet valves being arranged in axial series to correspond with the pistons. The drawings are so clear that probably the only comment necessary is to point out that in withdrawing the connecting-rod it is turned round so that the gudgeon pin can be taken out through the hole A in the guide.—*November 23rd*, 1933.

401,880. October 26th, 1932.—CYLINDER HEADS, E. Gardner and L. Gardner and Sons, Ltd., Barton Hall Engine Works, Patricroft, Manchester.

This engine is of the type which has a separate combustion chamber A in the cylinder head and the object of the invention is to encourage turbulence in the charge in the chamber. This is effected by providing a protuberance B on the piston, which

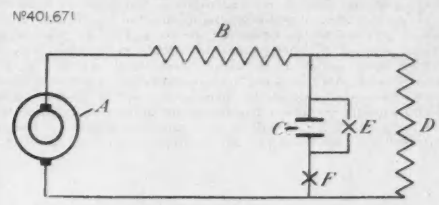


enters the port of the combustion chamber at the end of the stroke and partly obstructs that port. There is also a recess in the piston top at C. When the piston starts the working stroke the protuberance is withdrawn from the port and the gases, having free access, are not unduly cooled, so that starting from cold is facilitated. It is suggested that if the port is made triangular in shape, as shown in Fig. 2, the protruberance is unnecessary.—*November 23rd*, 1933.

DYNAMOS AND MOTORS.

401,671. May 13th, 1932.—MOTOR GENERATOR VOLTAGE REGULATION METHODS, Eric Johnson Timberlake, of "Lulworth," Pickhurst-rise, West Wickham, Kent, and the Electro Dynamic Construction Company, Ltd., of Devonshire-grove, London, S.E.15.

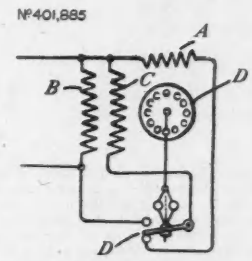
A method is described in this specification for maintaining the A.C. voltage of a rotary converter or motor generator constant with a fluctuating D.C. supply. Use is made of resistances generally known as barretters, the specific resistance of which varies widely with temperature and therefore with the current carried. A wattless load, consisting of a condenser, is connected in parallel with the external load. The barretter is connected in series with the total load, and the motor generator or rotary converter is designed so that any increase or decrease of the D.C. input voltage produces an increase or decrease respectively in the speed of the machine. Any increase of the D.C. supply voltage will produce an increase in frequency of the A.C., and the current through the condenser will increase proportionately to the increased frequency, in addition to any increase produced by a higher voltage. Owing to the position occupied in the circuit by the condenser any such increase of current passes through the barretter, and in so doing raises the temperature and the resistance. Consequently, the voltage drop across the barretter increases and tends to lower the voltage available for the external load. A represents the slip rings of the rotary converter or motor generator, B the barretter, C the



condenser, and D the main external load. At points E and F suitable regulating resistances may be inserted.—*November 13th*, 1933.

401,885. November 11th, 1932.—ELECTRIC MOTORS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.*

One object of this invention is to provide an arrangement for obtaining out-of-phase flexes in a single-phase motor for starting without providing external phase splitting means. Another object is to provide good starting torque with a low starting current. The motor shown has primary windings A, B, and C and a secondary member D represented as the rotor and provided with a usual form of squirrel-cage winding. Winding sections B and C are on the same axis and have an equal number of effective turns so that they may be connected in parallel without causing undesirable circulating currents. They may be con-

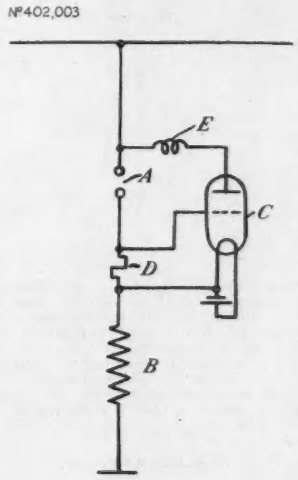


sidered the main winding, and winding A displaced by a suitable angle such as 90 electrical degrees, from the main winding, may be considered the starting winding. The winding A is connected in series with winding section C in a closed circuit for starting, and at this time winding section B, which is connected to the single-phase source of supply, acts as the primary of a transformer of which winding C is the secondary, and this transformer supplies current to the starting winding A as well as a motor flux in its own axis. The transformer action is modified by the presence of the short-circuited secondary D, in which currents are also induced by the fluxes in the two axes. An automatic speed responsive switch D is shown in the starting position provided to change from starting to running condition.—*November 23rd*, 1933.

TRANSMISSION OF POWER.

402,003. June 13th, 1933.—PROTECTIVE DEVICES FOR ELECTRIC CIRCUITS, *International General Electric Company, Inc., of 120, Broadway, New York, U.S.A.*

According to this invention a spark gap A in series with an impedance B is connected between the conductor to be protected against surge voltage and earth. The spark gap is shunted by a grid-controlled electric arc discharge device C, the grid potential of which is so controlled by current flowing through the spark gap as to cause the discharge device to be



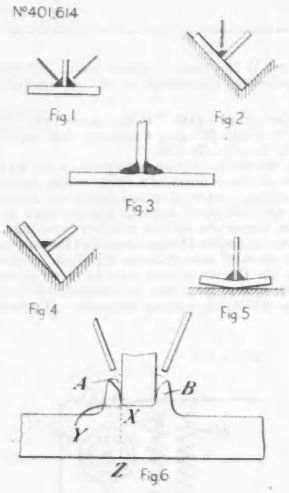
conductive and shunt the spark gap only when current flows through it. At all other times the discharge device remains non-conductive, and does not tend to provide a path for circuit current in parallel with the spark gap. In order to provide the desired control for the grid of the arc discharge device, the grid to cathode circuit may include a resistance D connected in series with the spark gap in such a way that when current flows through the spark gap the potential drop across the resistance makes the grid positive and initiates the current flow. E is a choke coil.—*November 23rd*, 1933.

WELDING.

401,614. June 19th, 1933.—STRUCTURAL WELDING, Dorman Long and Co., Ltd., Zetland-road, Middlesbrough, and E. T. Judge, 101, Borough-road, Middlesbrough.

The invention consists broadly in forming one of the sections to be joined with a groove adapted to receive the other section and leave symmetrical troughs on either side of such other section to receive the extraneous added welding metal. Referring to the drawings, it will be readily appreciated that it is difficult, according to the normal method, to weld at high speeds anything but the smallest fillets without depositing the metal vertically downwards, as shown by Fig. 2, since the welding

metal being in a molten state, will, if the welding is done with the sections disposed as shown in Fig. 1, tend to run into the undesired shape shown in Fig. 3. This defect when using simple sections necessitates in a large number of cases the welding of one fillet before the other in the position indicated by Fig. 2. This introduces distortion due to tilting of one section relative to the other, as shown in Fig. 4. Also, when a large amount of heat is generated at the welds when welding at high speeds, one of the simple sections shown in Fig. 1 is distorted or cambered owing to the contraction of the weld fillets, the finished joint taking the form shown in Fig. 5. By means of the present invention the foregoing defects are eliminated. Referring to Fig. 6, it will be seen that the spaces or troughs A to be filled with the deposited metal are formed by the shaped

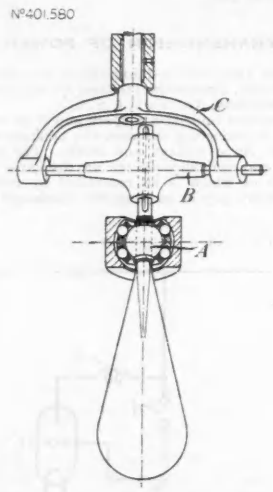


flanges B, and these spaces are shaped to hold the metal when welding is done in the position shown in the drawing. This enables both welds to be made simultaneously, without moving the work. The spaces or troughs are of gradually increasing cross-sectional area from the bottom upwards, and preferably the ratio of increase is more gradual from the bottom to an intermediate point than from this point to the top. In this way distortion due to tilting of one section relative to the other is overcome. Further, the shape of the section is such that contraction of the welds on cooling causes bending to take place at section X Y instead of at section X Z, and thus cambered distortion is eliminated. The bending at X Y tends to strengthen the joint, since, after welding, one section will be gripped in the groove of the other section.—*November 16th*, 1933.

SHIPS AND BOATS.

401,580. April 7th, 1933.—A FIN PROPELLER, W. Meindersma, 167, Buurtweg, Wassenaar, The Hague, Holland.

This invention relates to a mechanism for driving a fin

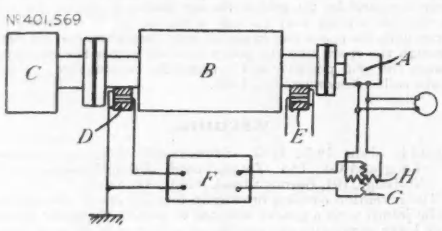


propeller which is movable about a centre of oscillation and of the kind in which the axis of the propeller describes a conical path during the time in which the propeller makes half a revolution round that axis. The propeller is mounted in a spherical ball bearing A, and is driven through the sliding cross piece B by the yoke C. The axes of the yoke and propeller are displaced sideways and in this way a conical motion is given to the propeller, which drives the boat forward. By making the displacement in the opposite direction, the propeller is reversed.—*November 16th*, 1933.

MISCELLANEOUS.

401,569. March 23rd, 1933.—MEANS FOR INVESTIGATING THE BALANCE OF ROTATING BODIES, *International General Electric Company, Incorporated, of 120, Broadway, New York, U.S.A.*

In balancing rotating bodies, in accordance with this invention,



a small two-pole synchronous generator A is coupled with the rotating body B to be balanced, its stator being rotatable through at least 180 deg. The body B is brought to any desired speed by a driving motor C. The voltage produced in the generator A and the forces taken up by crystal groups D and E are of the same frequency. The current of an amplifier F, which is controlled by one of the two groups of crystals is conducted through the coil G of a wattmeter. The other coil H is fed by the voltage of the auxiliary generator A. By rotating the stator of the generator, the maximum deflection of the instrument is produced. By considering the calibration curve of the arrangement and the value of the wattmeter deflection, the amplitude of the force to be measured is then obtained. The phase angle is determined from the amount of rotation of the stator which is necessary to produce maximum deflection. In order to determine the size of the phase angle more accurately, the stator may be rotated again until the deflection is zero, and an average value taken. In this arrangement the amplification factor, which depends upon the anode and grid voltage, must be known, so as to determine the value of the measurement. It is possible to be independent of the characteristic of the amplifier, however, by compensating the alternating voltages arising at the crystals before entering the amplifier.—*November 16th*, 1933.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF SANITARY ENGINEERS.—Caxton Hall, S.W.1. Presidential address, Mr. Godfrey M. C. Taylor. 6 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Reproduction of Engineering Drawings," Mr. G. V. Rickards. 7.30 p.m.

SATURDAY, JANUARY 6TH.

INST. OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Engineers' Club, Albert-square, Manchester. "Pattern-maker's Foundry Sense," Mr. F. C. Edwards. 4 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Visit to the Leeds Corporation gasworks, Meadow-lane, Leeds. 3 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Christmas Juvenile Lecture. "Through Space and Time: The Further Stars," Sir James Jeans. 3 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield. Club dance. 7.30 to 11 p.m.

MONDAY, JANUARY 8TH.

BRADFORD ENGINEERING SOC.—Technical College, Bradford. "Leadburning and Copper and Iron Welding for Plumbers and Heating Engineers," Mr. E. B. Partington. 7.30 p.m.

CHARTERED SURVEYORS' INST.—12, Great George-street, S.W.1. "The Trend of Population," Professor A. M. Carr-Saunders. 8 p.m.

ELECTRODEPOSITORS' TECHNICAL SOC.: MIDLAND CENTRE.—James Watt Memorial Inst., Birmingham, 3. "Electrodeposition for Wear Resistance," Dr. J. Kronsbein. 7.30 p.m.

INST. OF CHEMICAL ENGINEERS.—Joint meeting with Soc. of Chemical Industry. In Rooms of Chemical Soc., Burlington House, W.1. "Legal Pitfalls for the Chemical Engineer," Mr. J. D. Pratt and Mr. G. S. W. Marlow. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: NORTH-EASTERN CENTRE.—Armstrong College, Newcastle-upon-Tyne. "Electro-magnetic Phenomena in High-voltage Testing Equipment," Mr. B. L. Goodlet. 7 p.m.

INST. OF PRODUCTION ENGINEERS.—College of Technology, Manchester. "Industrial Applications of Welding," Dr. J. H. Paterson. 7.30 p.m.

INST. OF TRANSPORT.—London meeting. "The 'Royal Scot' in Canada and the U.S.A.," Mr. E. J. H. Lemon.

STEPHENSON LOCOMOTIVE SOC.—King's Cross Station, N.1. "The Railways of Switzerland over Mountain and Plain," Mr. R. A. H. Waight. 6.30 p.m.

TUESDAY, JANUARY 9TH.

HULL ASSOC. OF ENGINEERS.—Municipal Technical College, Park-street, Hull. "Manufacture of Glass," Dr. W. M. Hampton. 7.15 p.m.

ILLUMINATING ENGINEERING SOC.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Portable Lamps and their Applications," Mr. A. Cunningham. 6.30 p.m.

INST. OF AUTOMOBILE ENGINEERS.—King's Head Hotel, Coventry. "Electrical Equipment for Automobiles," Mr. E. A. Watson. 7.30 p.m.

INST. OF BRTIISH FOUNDRYMEN: LANCASHIRE BRANCH, BURNLEY SECTION.—At Municipal College, Ormerod-road, Burnley. "Blast-furnace Practice and Notes on Making of Irons," Mr. W. Wilkinson. 7.30 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Discussion, "Equipment for Handling Phosphate Rock at Nauru and Ocean Island," Mr. Cecil Bentham. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND CENTRE.—Hotel Metropole, Leeds. "Bypath Automatic Telephone System," Messrs. J. H. E. Baker and E. P. G. Wright. 7 p.m.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. "Steels in Marine Engineering Service," Mr. T. H. Burnham. 6 p.m.

INST. OF METALS: N.E. COAST LOCAL SECTION.—Armstrong College, Newcastle-upon-Tyne. "Physical Properties of Deposited Weld Metal in the Arc-welding and Atomic Hydrogen Processes," Messrs. C. R. Deglon and L. Miller. 7.30 p.m.

INST. OF PETROLEUM TECHNOLOGISTS.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "Oxidation Lubrication and the Blending of Mineral Oils to Obtain Maximum Lubricating Value," Mr. R. O. King. 5.30 p.m.

INST. OF TRANSPORT: BIRMINGHAM AND DISTRICT MEETING. "Transport and Decentralisation," Sir Herbert Austin.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Christmas Juvenile Lecture, "Through Space and Time: The Nebulæ," Sir James Jeans. 3 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. Annual general meeting, Presidential Address. 7.30 p.m.

TUESDAY TO THURSDAY, JANUARY 9TH TO 11TH.

PHYSICAL SOCIETY.—At Imperial College of Science and Technology, S. Kensington, S.W.7. Exhibition. Open 3 p.m. Discourse, "Evolution of the Galvanometer," Mr. R. S. Whipple, at 8 p.m. Wednesday: Open 4 p.m., discourse, "Instrumental Side of Calorimetry," Mr. J. Guild, at 8 p.m. —Thursday: Open 3 p.m., discourse, "History and Development of the Thermionic Valve," Sir J. Ambrose Fleming, F.R.S., at 8 p.m.

WEDNESDAY, JANUARY 10TH.

INST. OF BRITISH FOUNDRYMEN: PRESTON SECTION.—At Technical College, Corporation-street, Preston. "Mechanisation of the Foundry," Mr. E. France. 7.30 p.m.

INST. OF ENGINEERS-IN-CHARGE.—St. Bride Inst., Bride-lane, Fleet-street, E.C.4. "Case for the Private Plant," Mr. E. G. Phillips. 7.30 p.m.

INST. OF PRODUCTION ENGINEERS.—King's Head Hotel, Coventry. "Internal Transport in an Automobile Factory," Mr. W. L. Beeby. 7.30 p.m.

SOC. OF GLASS TECHNOLOGY: LONDON SECTION.—At Offices of Holophane, Ltd., Elverton-street, Westminster, S.W.1. "Some Modern Uses of Glass," Mr. G. Novell. 7.30 p.m.

THURSDAY, JANUARY 11TH.

INST. OF AUTOMOBILE ENGINEERS.—At Merchant Venturers' Technical College, Bristol. "Development of a Constant-Periodicity Suspension System," Mr. S. A. Horstmann. 7 p.m.

INST. OF ENGINEERING INSPECTION.—At Junior Inst. of Engineers, 39, Victoria-street, S.W.1. "Internal Factory Inspection," Mr. F. Lawrence. 5.45 p.m.

INST. OF MARINE ENGINEERS: JUNIOR SECTION.—85–88, The Minories, E.C.3. "Stern Tubes and Tail-end Bearings," Mr. A. C. West. 7 p.m.

INST. OF METALS: LONDON LOCAL SECTION.—At Soc. of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. "Beryllium and its Alloys," Mr. H. A. Sloman. 7.30 p.m.

ROYAL AERONAUTICAL SOC.—Lecture postponed.

FRIDAY, JANUARY 12TH.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. Mr. B. D. Parritt will introduce discussion on "Rubber and its Engineering Uses." 7 p.m.

INST. OF METALS: SHEFFIELD LOCAL SECTION.—The University, Sheffield. "Protection from Corrosion of Aluminium and its Alloys," Mr. N. D. Pullen. 7.30 p.m.

INST. OF PRODUCTION ENGINEERS.—Merchant Venturers' College, Bristol. "Modern Foundry Production Methods," Mr. J. J. Shechan. 7.30 p.m.

INST. OF TRANSPORT: NEWCASTLE-UPON-TYNE AND DISTRICT SECTION.—"Future Developments in Air Transport," Mr. W. L. Runciman.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1.—"Colour Light Signals for Road Traffic," Mr. H. J. N. Riddle. 7.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—At Mining Inst., Newcastle-upon-Tyne. "Shipbuilding in relation to Subsequent Repairs," Messrs. E. and E. P. Wilson. 6 p.m.

RAILWAY CLUB.—57, Fetter-lane, E.C.4. "Why the L. and N.W. Railway was the Premier Line," Mr. J. D. Godfrey. 7.30 p.m.

SOC. OF CHEMICAL INDUSTRY: PLASTICS GROUP.—At Chemical Soc., Burlington House, W.1. "Plastics as Engineering Material," Mr. Herbert W. Rowell. 8 p.m.

SATURDAY, JANUARY 13TH.

INST. OF CIVIL ENGINEERS.—Students' afternoon visit to Croydon Aerodrome.

INST. OF MARINE ENGINEERS: JUNIOR SECTION.—Social and dance. 7.30 p.m. to 11.15 p.m.

INST. OF PRODUCTION ENGINEERS.—Castle-street Hall, Luton. "Functions of the Production Engineer," Mr. J. Ronald. 7.30 p.m.

MONDAY, JANUARY 15TH.

INST. OF AUTOMOBILE ENGINEERS.—At Inst. of Engineers and Shipbuilders, 39, Elmbank-crescent, Glasgow. "Development of a Constant-Periodicity Suspension System," Mr. S. A. Horstmann. 7.30 p.m.

INST. OF METALS: SCOTTISH LOCAL SECTION.—39, Elmbank-crescent, Glasgow. "Factors in the Solidification of Molten Metals," Dr. Sydney W. Smith. 7.30 p.m.

TUESDAY, JANUARY 16TH.

BRITISH ASSOC. OF REFRIGERATION.—At Inst. of Marine Engineers, 85–88, The Minories, London, E.C.3. "Some Chemical Aspects of Refrigeration," Major F. A. Freeth, F.R.S. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Hotel Metropole, Leeds. "A.C. Crane Control and Operation," Mr. H. Thompson. 7.15 p.m.

INSTITUTIONS OF MECHANICAL AND ELECTRICAL ENGINEERS: GRADUATE AND STUDENT SECTIONS AND LONDON STUDENTS OF CIVIL ENGINEERING.—Joint Dance at Victoria Halls. 7.30 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—James Watt Memorial Inst., Birmingham. "Electric Welding," Mr. C. A. Hadley. 7 p.m.

INST. OF TRANSPORT.—London meeting. "The British Coasting Trade and its National Importance," Mr. J. R. Cowper.

WEDNESDAY, JANUARY 17TH.

INST. OF AUTOMOBILE ENGINEERS.—Metropole Hotel, King-street, Leeds. "Repairs," Mr. J. Dent. 7.15 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Discussion, "Transition Curves and Superelevation on Roads," Mr. E. L. Leeming. 6 p.m.

MANCHESTER METALLURGICAL SOC.—Joint Meeting with Inst. of British Foundrymen, Engineers' Club, Manchester. "Bearing Metals," Mr. A. J. Murphy.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "Modern Developments in Street Lighting," Mr. J. M. Waldram. 8 p.m.

SOC. DES INGENIEURS CIVILS DE FRANCE: BRITISH SECTION.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Port of Algiers and the Mustapha Jetty," M. Bénézit. 6 p.m.

THURSDAY, JANUARY 18TH.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. "The London Building Act of 1930 and its Effect on Structural Design," Mr. W. C. Cocking. 7 p.m.

LIVERPOOL ENGINEERING SOC.—Adelphi Hotel, Liverpool. Annual dinner. 7 p.m. for 7.30 p.m.

FRIDAY, JANUARY 19TH.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. "Presentation and Discussion of a Symposium of Papers Dealing with Invention." 6 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Some Modern Developments in Fire Extinguishment," Mr. E. C. Prince. 7.30 p.m.

UNIVERSITY OF LONDON.—King's College, Strand, W.C.2. "Apparatus for Power Factor Correction," Mr. D. B. Hoseason. 5.30 p.m.

SATURDAY, JANUARY 20TH.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Visit to works of John Lumb and Co., Ltd., glass bottle manufacturers, Castleford. 3.15 p.m.

MONDAY, JANUARY 22ND.

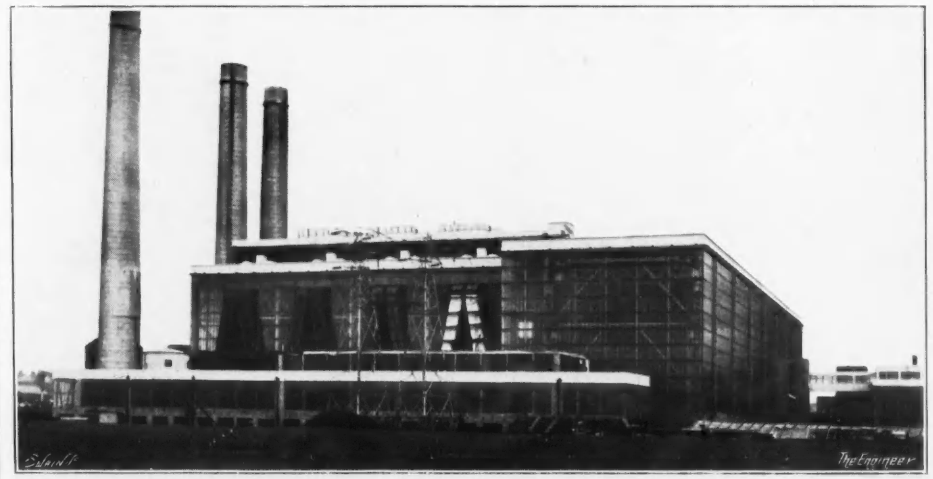
INST. OF MECHANICAL ENGINEERS: GRADUATES.—Storey's-gate, S.W.1. "New Cutting Alloys," Mr. C. R. Perks. 6.45 p.m.

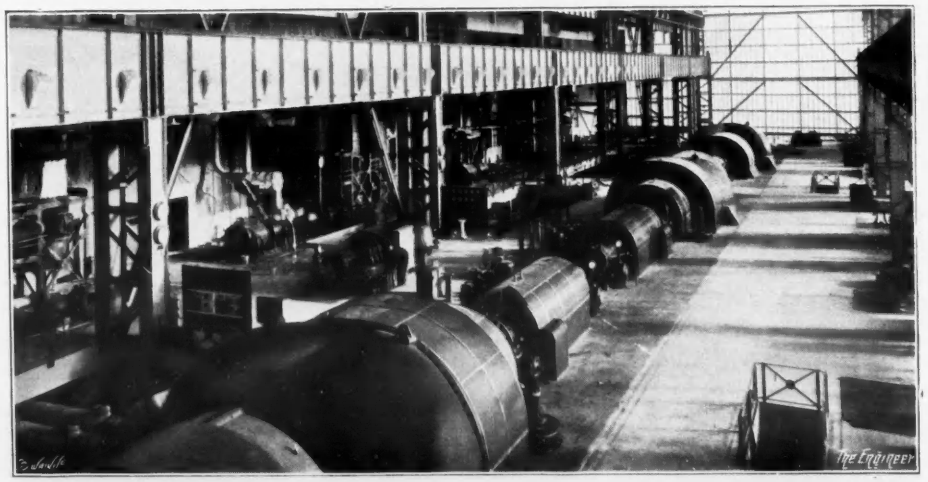
TUESDAY, JANUARY 23RD.

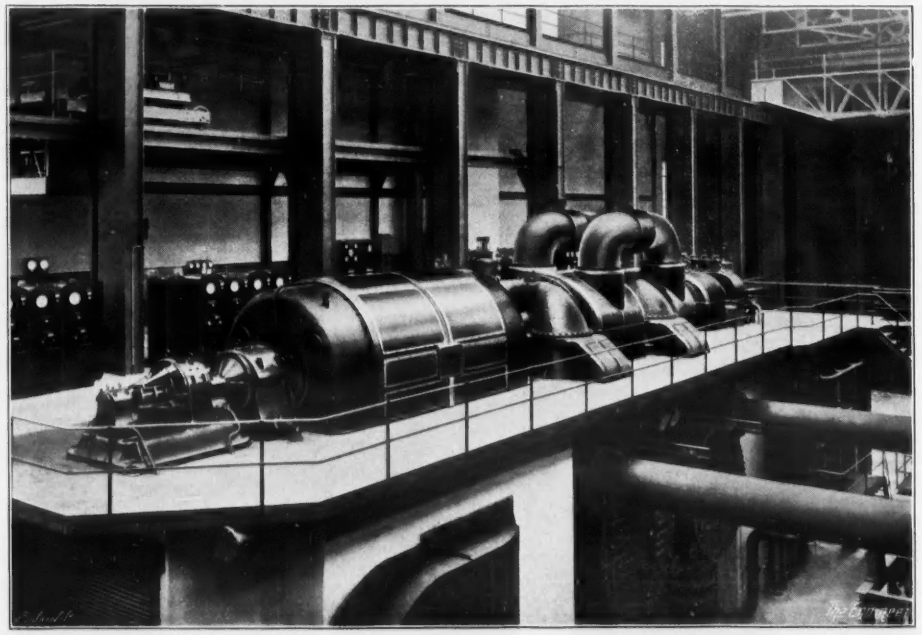
STEPHENSON LOCOMOTIVE SOC.: SCOTTISH BRANCH.—Royal Technical College, Glasgow. "Some Railway Travels," illustrated by lantern. Mr. John McInnes. 7.45 p.m.

WEDNESDAY, JANUARY 24TH.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "Modern International Practice in Factory Design," Mr. Hal Williams. 8 p.m.







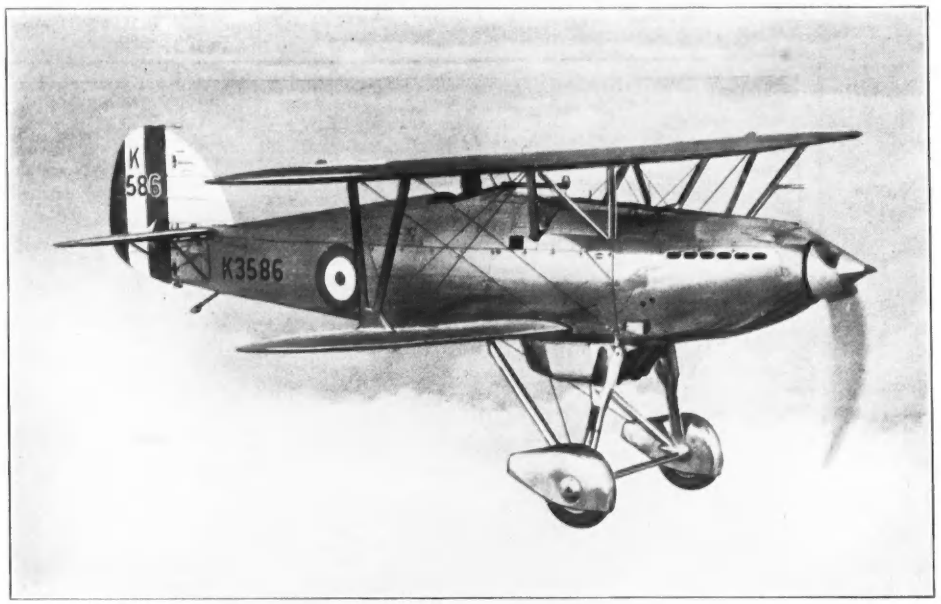
ABOVE:—THE NEW DUNSTON POWER STATION
BELOW:—THE BLACKBURN MEADOWS POWER STATION

ABOVE: DUNSTON TURBINE ROOM
BELOW: BLACKBURN MEADOWS TURBINE ROOM

UNIV. OF MICH.

SOME AIRCRAFT OF 1933

CIERVA DIRECT CONTROL WINGLESS TWO-SEATER AUTOGIRO

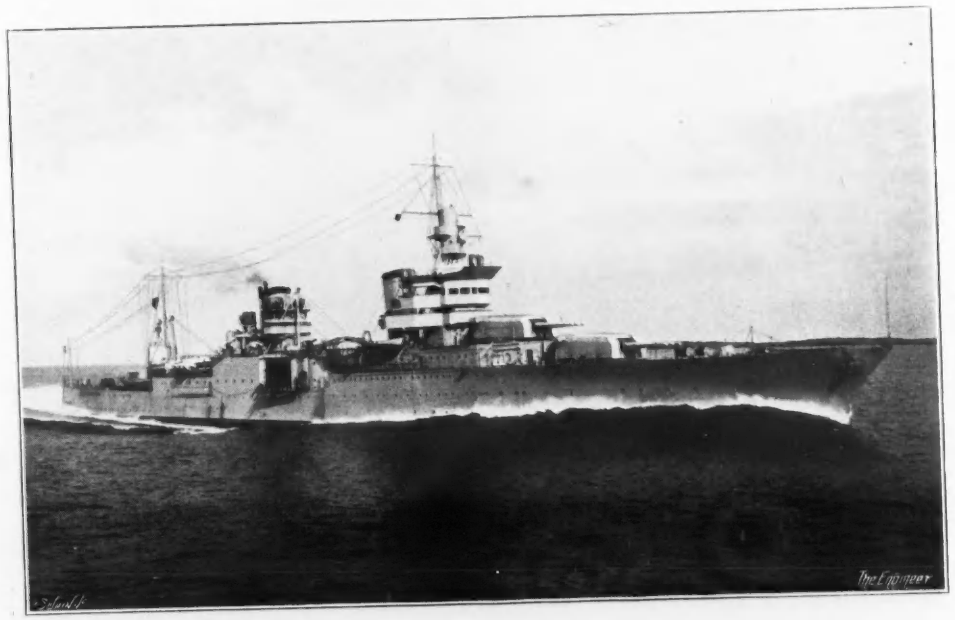


HAWKER "SUPER-FURY" SINGLE-SEATER FIGHTER

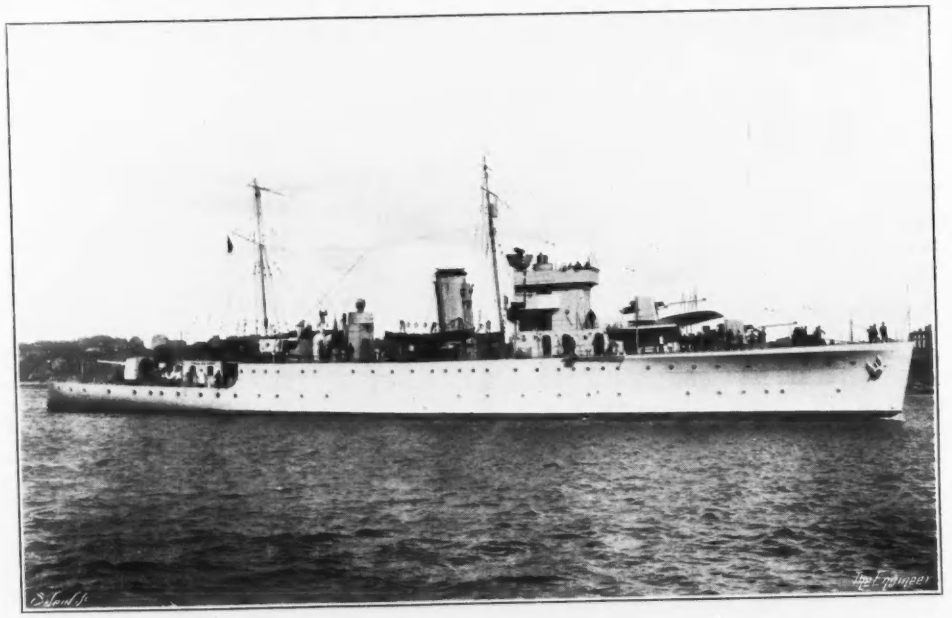
WESTLAND "WALLACE" MOUNT EVEREST FLIGHT MACHINE

GLOSTER "GAUNTLET" DAY-AND-NIGHT HIGH ALTITUDE FIGHTER

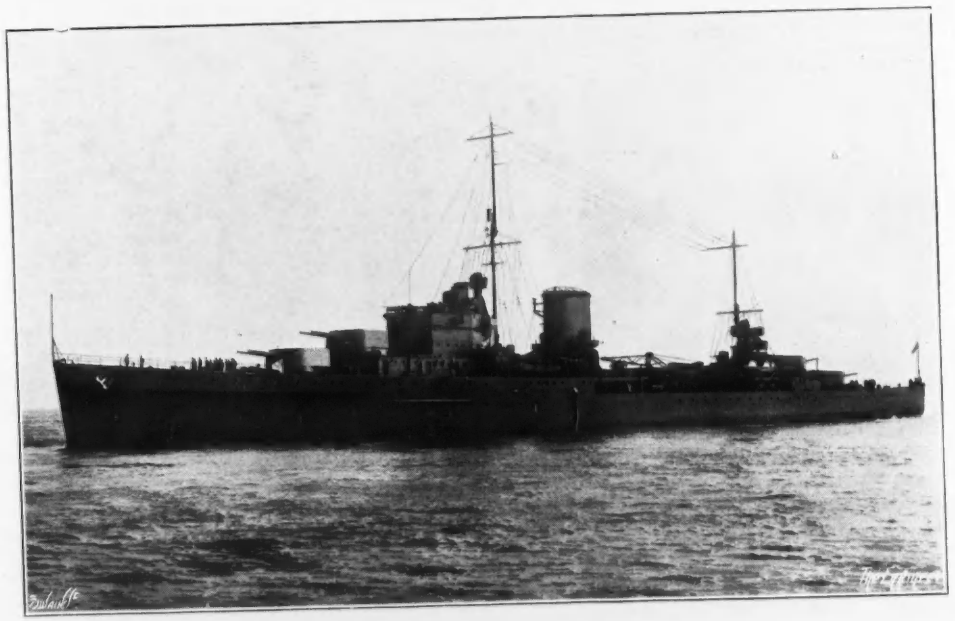
SOME WARSHIPS OF 1933



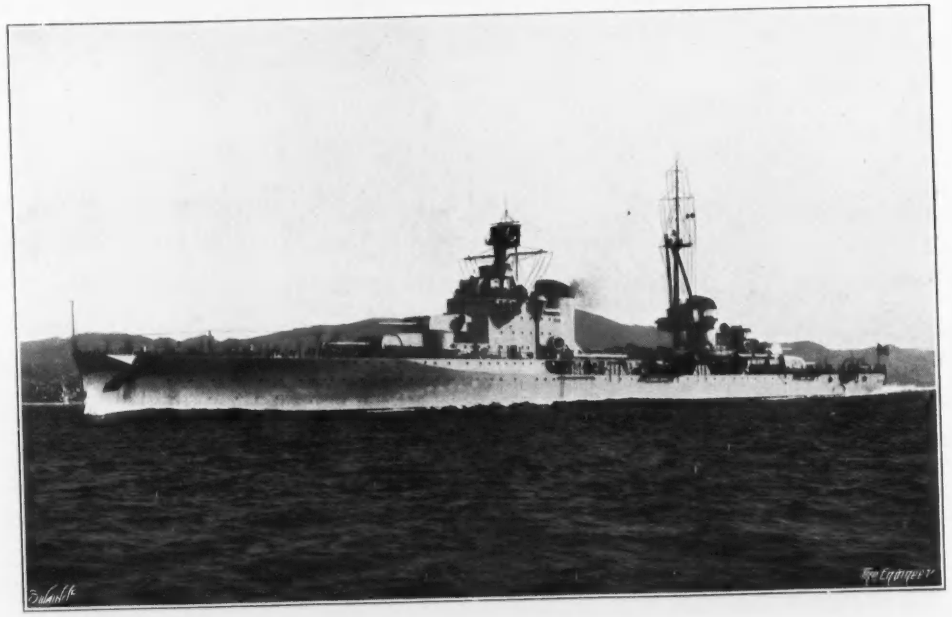
U.S. CRUISER "PORTLAND"



PORTUGUESE SLOOP "GONÇALVEZ ZARCO"



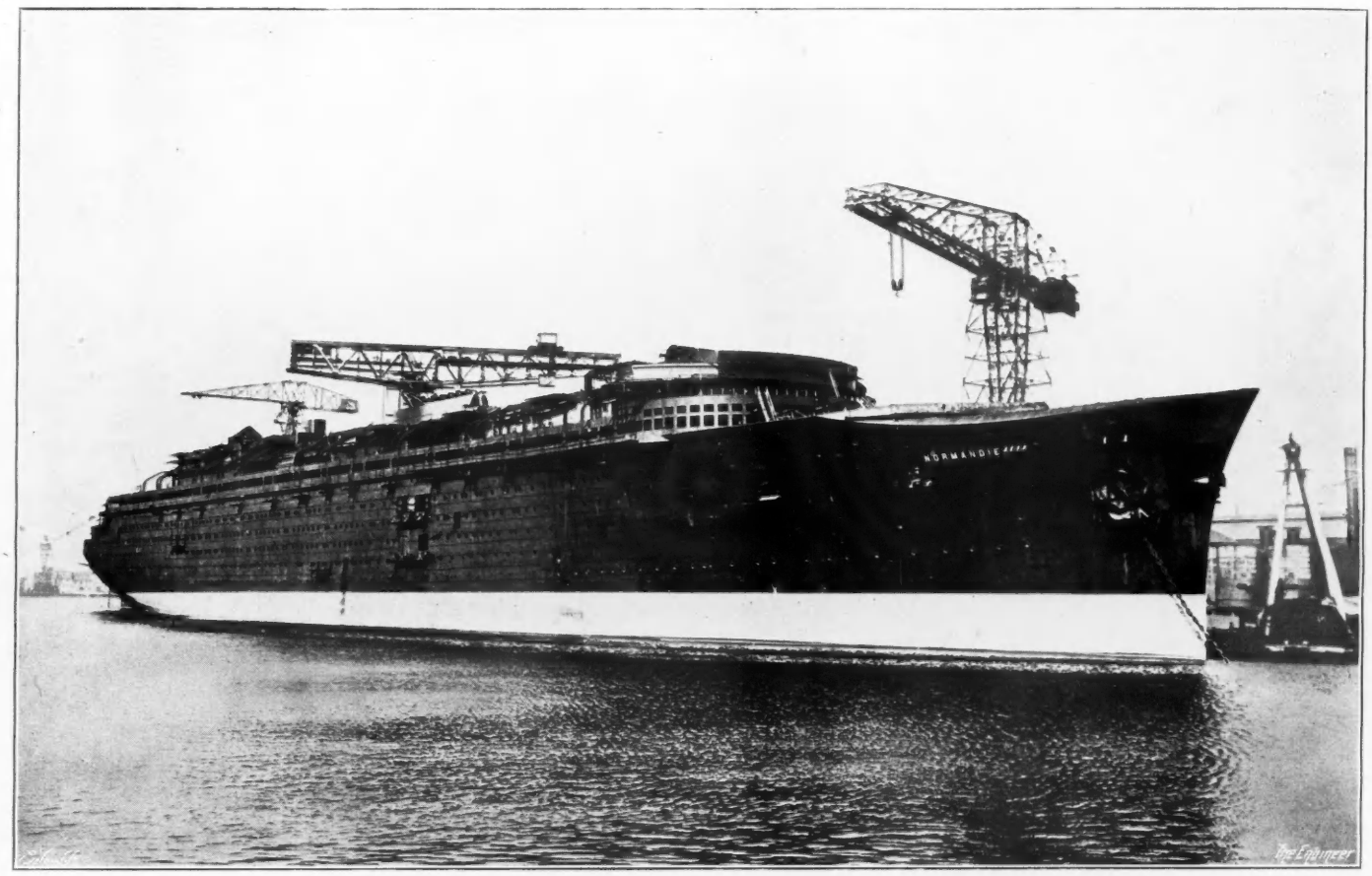
H.M. LIGHT CRUISER "ACHILLES"



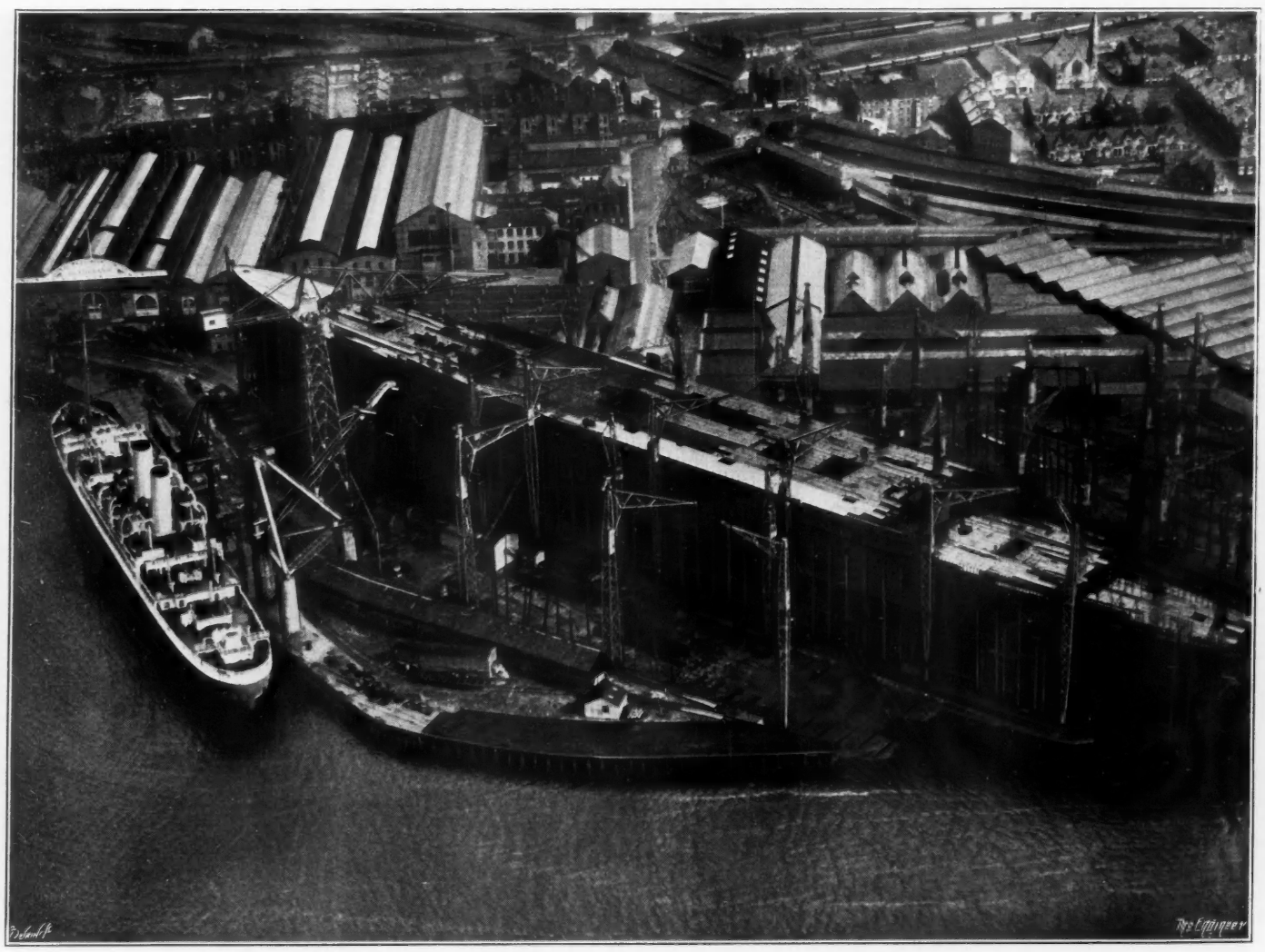
ITALIAN CRUISER "BOLZANO"

ONE OF EIGHT

THE WORLD'S TWO LARGEST LINERS—1933

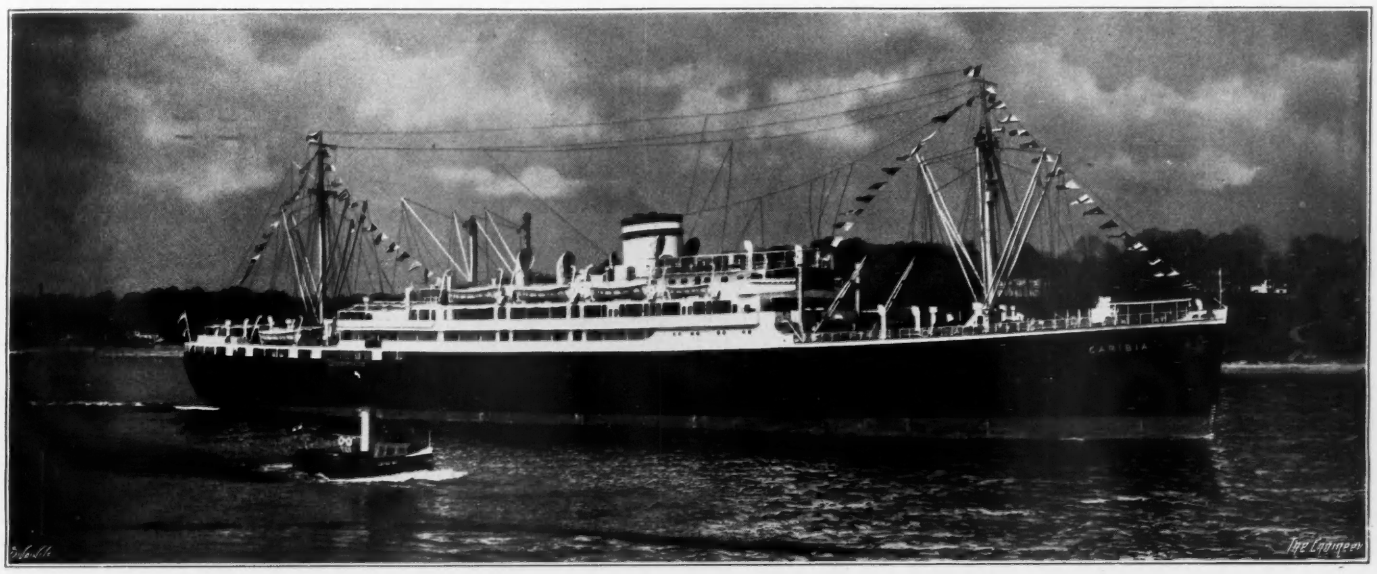


The French Line 75,000-Ton Liner "Normandie" Fitting-out at St. Nazaire

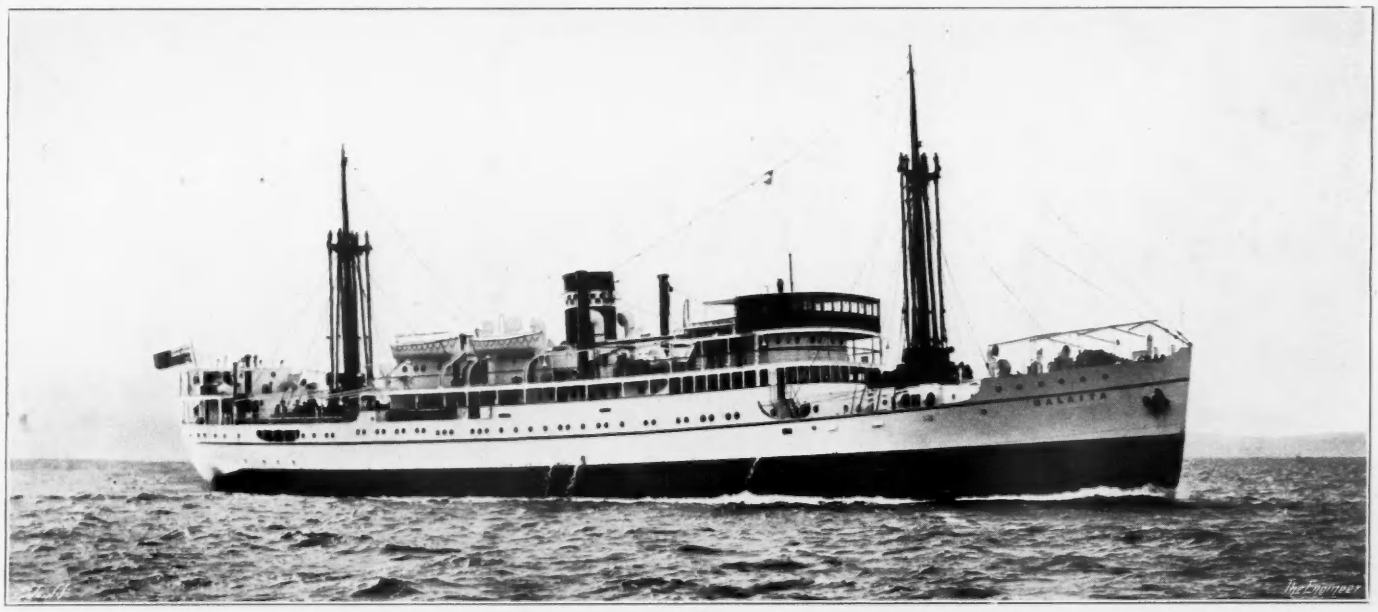


The Cunard Line 73,000-Ton Liner No. 534 on the Stocks at Clydebank

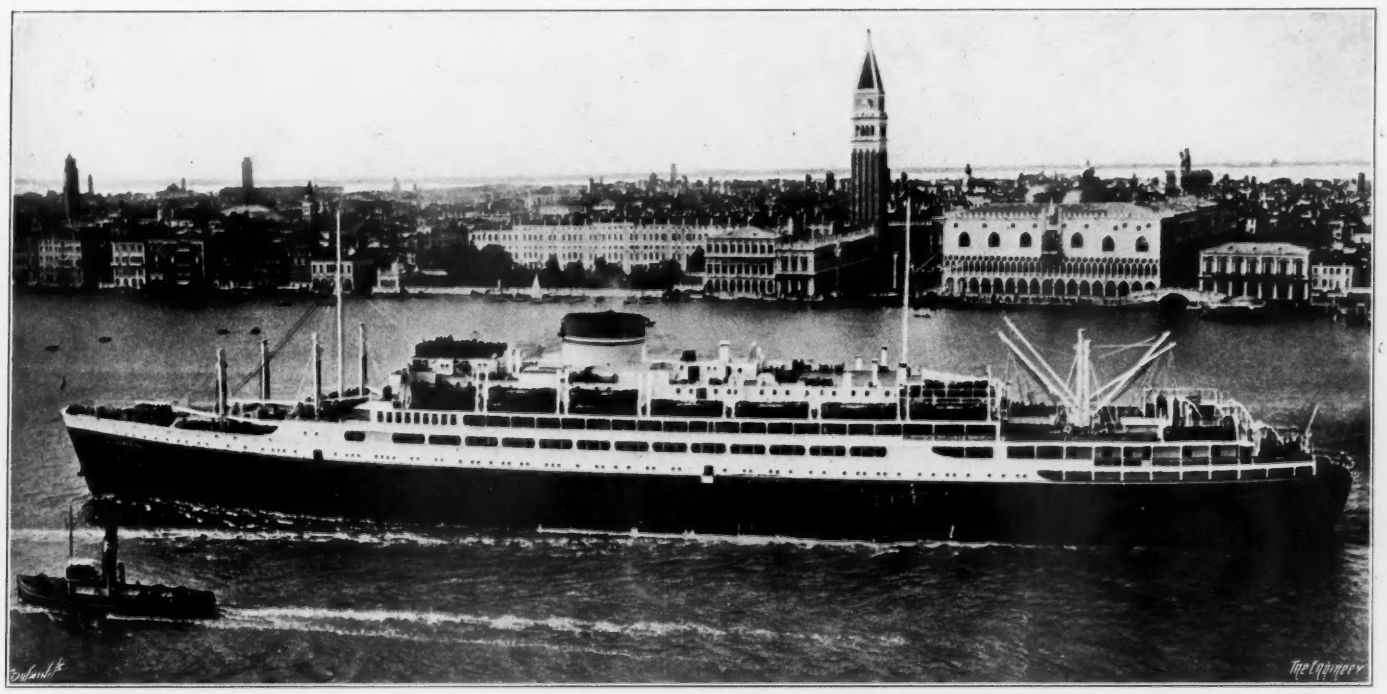
SOME MOTOR LINERS OF 1933



THE HAMBURG-AMERICAN LINER "CARIBIA"



THE BURNS PHILP LINER "MALAITA"

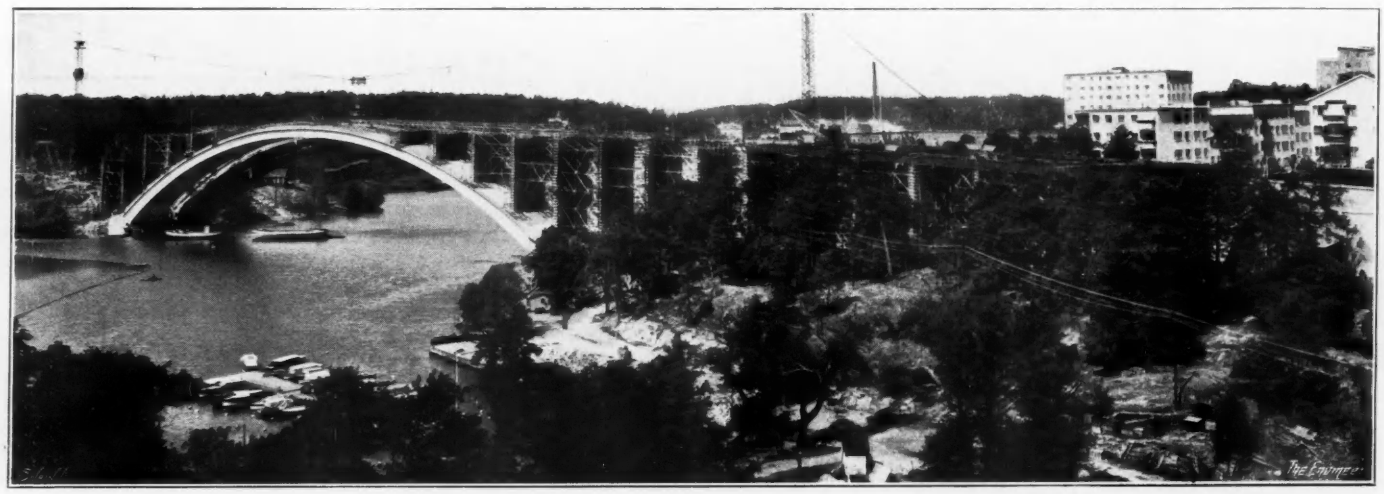


THE COSULICH LINER "OCEANIA"

BMH. OF WOH.

SOME BRIDGES OF 1933

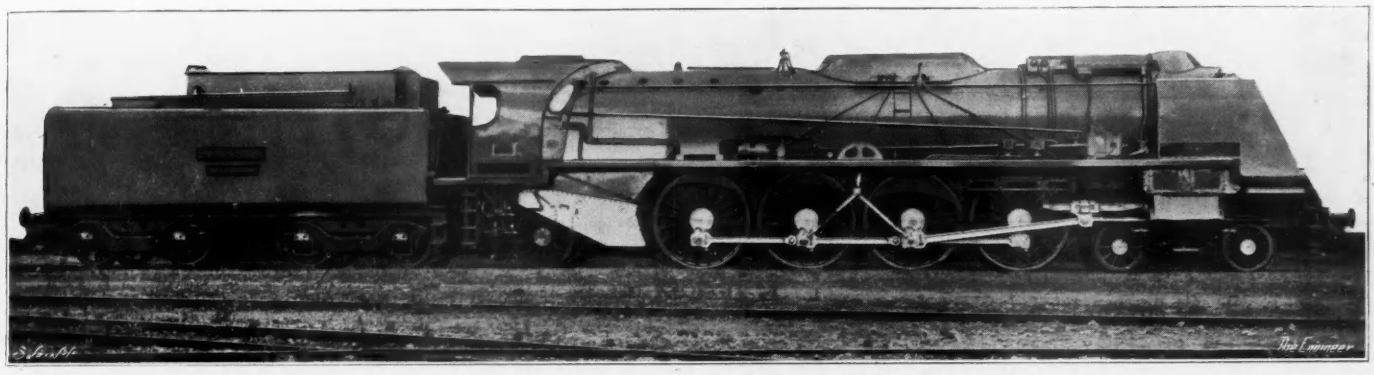
TWICKENHAM BRIDGE



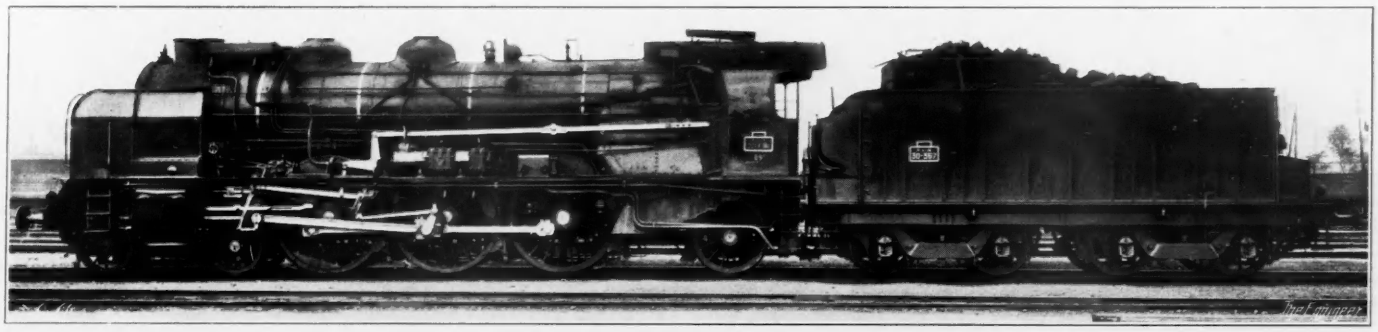
THE TRANEBERG ARCH BRIDGE, STOCKHOLM

THE TEES VERTICAL LIFT DRAWBRIDGE, MIDDLESBROUGH

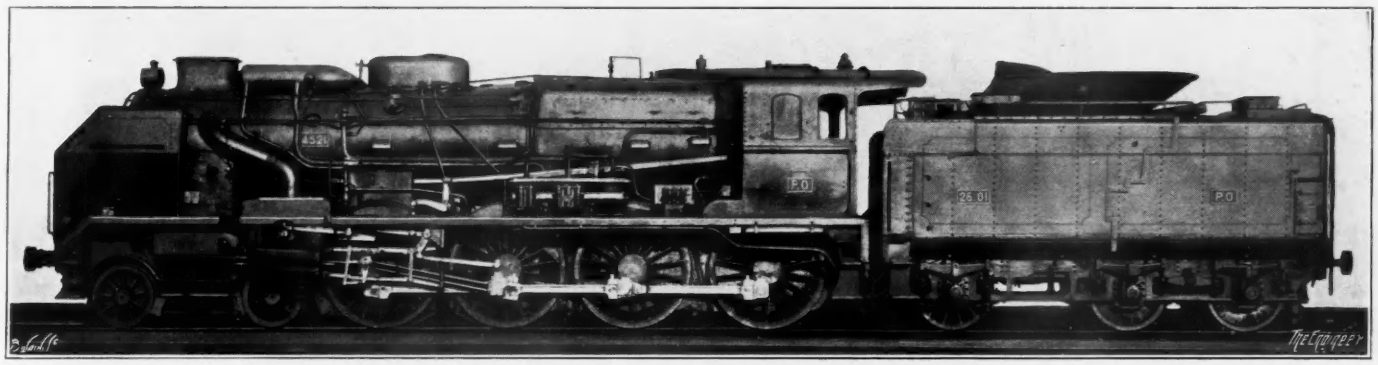
SOME STEAM LOCOMOTIVES OF 1933



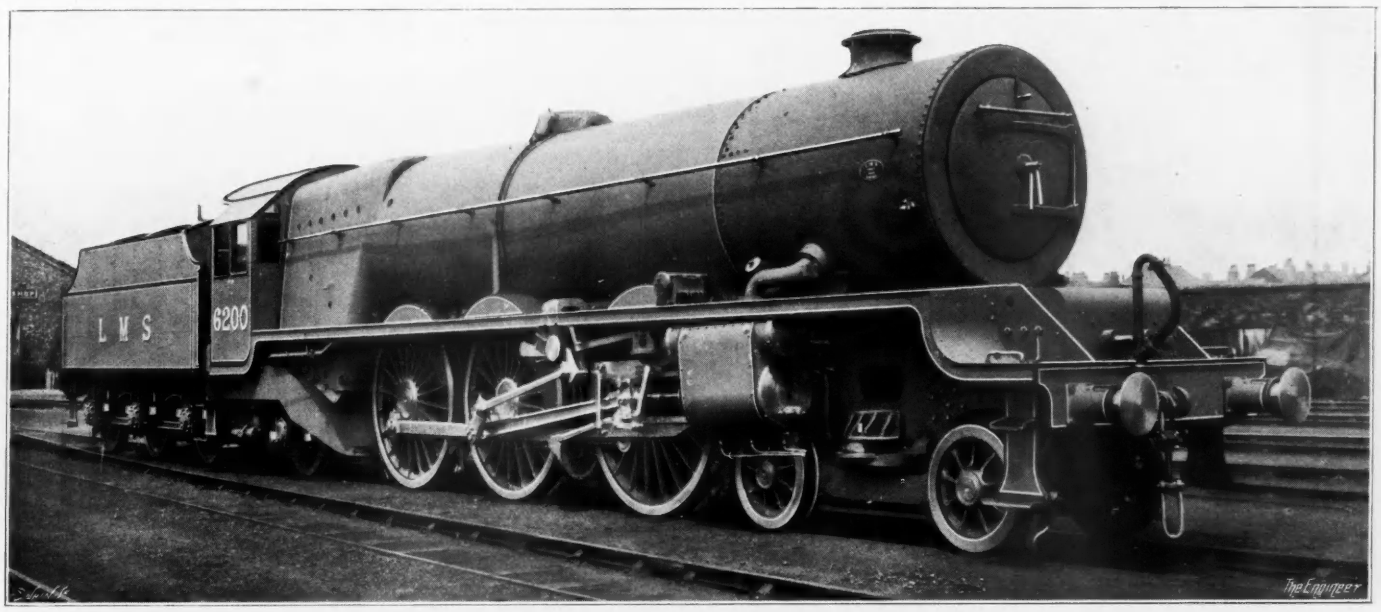
ETAT MOUNTAIN TYPE LOCOMOTIVE



P.L.M. 4-6-2 EXPRESS LOCOMOTIVE

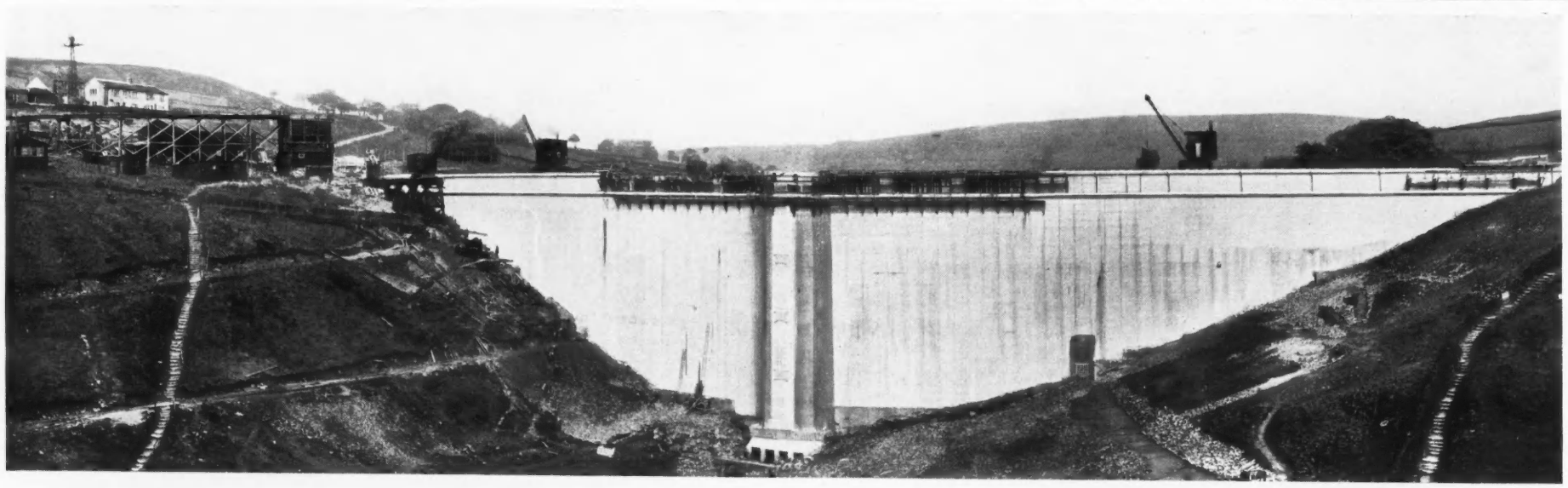


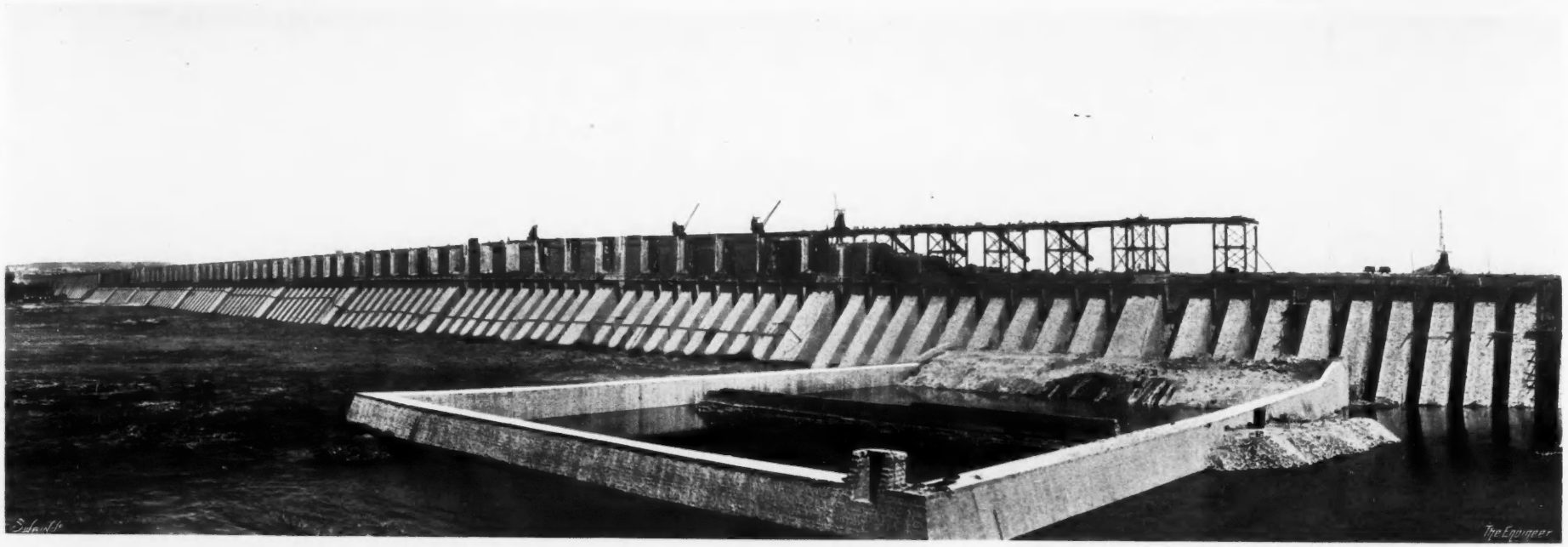
P.O. 4-8-0 EXPRESS LOCOMOTIVE



L.M.S. PASSENGER LOCOMOTIVE "PRINCESS ROYAL"

UNIV OF TOKYO





ABOVE:—THE RYBURN DAM
BELOW:—THE ASWAN DAM

A Seven-Day Journal

Canadian Railway Co-operation.

IN the course of a telegram sent by Mr. E. W. Beatty, President of the Canadian Pacific Railway, to Sir George McLaren Brown, the European general manager of the company, Mr. Beatty refers to the improvement in conditions in Canada which has been shown in the last few months, and which, if sustained, will bring about a better year in 1934. Following the directions of the Canadian National Canadian Pacific Act of 1933, Joint Committees of the Canadian Pacific and Canadian National Railways have been studying methods of eliminating the costly duplications of services which militate against the remunerative operation of both systems. With the appointment by the Government of the new C.N.R. Board of Trustees, which has full power under the Act to co-operate with the directors of the Canadian Pacific Railway, it is expected that the measures of co-operation which have been recommended by the Committees will be extended in the hope of still further improving the financial position of both railways. Mr. Beatty pays a tribute to the fine spirit shown by both the officers and employees, which, he feels sure, will enable any difficulties to be overcome which may for the time being hamper progress.

French Import Quotas.

THE conditions under which import quotas into France have been fixed for the present quarter make clear the position which the French Government has taken up in the negotiations now proceeding with different countries for commercial treaties. In the first place, the quotas are substantially the same as those for the previous three months, but only a quarter of them are allotted to importers, the remaining 75 per cent. being reserved by the Government for the purpose of negotiating with other countries. The quotas have, moreover, been extended to more than a hundred additional categories of goods, and there has been a rearrangement which brings some of the products imported under a higher tariff scale than was previously applicable to them. This does not necessarily imply a tendency to restrict imports unduly, for it is announced that the quotas may be increased up to 300 per cent., which obviously gives the Government a fair margin for reciprocal exchanges. The French have provided themselves, within limits, with an elastic system of negotiating commercial arrangements upon a basis of strict reciprocity, and as long deliberations on hundreds of different articles may be entailed, it can be presumed that some time will yet elapse before the negotiations for an Anglo-French treaty are concluded. One hope of a comparatively early settlement lies in the anxiety of the French to complete arrangements with this country. An Anglo-French agreement means a great deal to the commercial future of France, and should have a favourable influence upon her relations with other countries.

An Indian Power Line Contract.

WE are able to state that British Insulated Cables, Ltd., of London and Prescot, Lancashire, has received from the Madras Government the official order for an important overhead power transmission line from Erode to Trichinopoly, which is to work in connection with the Pykara hydro-electric development scheme, the official opening of which was described in a Journal note of April 14th, 1933. The new line will consist of 82 miles route length of double-circuit, three-phase, 66,000-volt line, and will comprise the work of supplying and erecting some 600 lattice masts supporting six-line conductors, each of 7/0·144in. aluminium steel reinforced strand, with an earth conductor of 7/10 S.W.G. steel, suspended above the line conductors. The height of the masts will be 52ft., and the average span length between the supports 750ft. The line conductors will be carried on suspension insulators, consisting of five discs per string, six discs being employed for the tension strings at both the terminal and the strain towers. The Pykara hydro-electric installation makes use of the waters of the Pykara River, which drains the Nilgiri plateau, and the 3080ft. head of water used at the power station to drive the three 10,900 H.P. generator sets is stated to be the largest in the British Empire. The order above referred to is for the 66,000-volt distribution lines, and has a value of about £56,000.

The Georges Philippar Disaster.

THE outcome of the judicial inquiry into the disaster which occurred on the French motor liner "Georges Philippar," in May, 1932, is that proceedings are to be taken against seven persons for manslaughter, and that, in the near future, several other persons are likely to be similarly indicted. All are to be charged with imprudence, negligence, lack of skill, and failure to observe regulations. Among those so charged are, we learn, high officials of the Messageries Maritimes, the owners of the ship, and the builders, the Loire Shipyards. The judicial inquiry has been based on the technical report of the Commission nominated by the Minister of the Merchant Marine to investigate the disaster and its causes, which was presented in August last, but has not yet been officially published. It will be recalled that in July, 1932, British underwriters took the very rare step of calling upon the French owners to refund to them the sum paid promptly after the loss of the ship on the grounds of delay in forwarding the report of the Commission, particularly as in the terms of settlement it was expressly set forth that should the report establish that the loss was due to causes from which the underwriters were not liable, then they would have to reconsider their position. The proceedings which are now to follow the judicial inquiry would seem to warrant the action which was taken by the underwriters.

Rugby Wireless Beacon.

THE possibility of an air disaster similar to that which took place in Belgium on Saturday, December 30th, and was recorded in last week's Journal, was foreseen some months ago by the Air Ministry. At a conference held in June last it was decided to erect at the Rugby wireless station a danger beacon, which would be visible in the air for a range of 50 miles. Work was entrusted to the General Electric Company, Ltd., of London and Witton, and was begun in November last. It will be completed in a few days time. The beacon is placed in the middle of twelve 812ft. main masts and smaller masts and stands on the top of a 35ft. tower. It consists of a Neon sign, 14ft. in height, which is made up of over 180ft. of Neon tubing. The signal is of the non-flashing type, and in normal weather may be discerned over a range of about 50 miles around the station. When there is a fog the glow acts as a warning light to pilots and can be readily seen over a large area around the wireless station.

The Anglo-Continental Ship-plate Agreement.

THE announcement of the agreement between the British and Continental ship-plate manufacturers, which was foreshadowed in our issue of January 5th, is an interesting experiment in international trade arrangements. Agreements regarding prices and markets have existed for some time between the British, Continental, and American steel rail and tube makers, and in pursuing a similar policy the manufacturers of ship plates and steel sections used in shipbuilding are moving with the modern tendency towards international agreement in export markets as against unrestricted competition. As we have pointed out, competition between the British and Continental makers to secure orders for ship plates and sections resulted in ridiculously cheap prices being accepted, and this reacted unfavourably upon British shipbuilding when it had to compete with Continental shipyards. The new arrangement is between the British, German, French, Belgian, and Luxemburg makers. It provides that Great Britain and the Empire markets shall be reserved for the British steel makers, but it also covers prices and fixed tonnage quotas for neutral markets. The scheme is to be given a trial for six months, and in this respect must be regarded as an experiment. The successful carrying through of the negotiations by the British Steel Export Association is a distinct achievement, although there may be points in the new arrangement which will not be favourably regarded either here or on the Continent; but that is the fate of all international trade agreements. For instance, it is doubtful if the centralisation of sales in the British Steel Export Association and the German Stahlwerksverband will be universally popular.

Reinforced Concrete Building Practice.

THE report of the Reinforced Concrete Structures Committee of the Building Research Board, which has been issued by the Department of Scientific and Industrial Research and may be obtained from the Stationery Office, contains the findings of the Committee, under the chairmanship of Sir George Humphreys, which was appointed in 1931 to review present methods and regulations for the use of reinforced concrete in building and to make recommendations for rules of practice embodying the best available technical information and experience. The Committee's recommendations are set out in a new code of practice appended to the report, which has been drawn up in such a manner as to assure good practice, while not handicapping progress, and to leave the door open to the adoption of new methods where these are adequately established. The Committee proposes three grades of concrete. The first, or ordinary grade, corresponds to the 750 lb. per square inch grade, and is for use where rigid control is not exercised. The second, or high grade, calls for proof of strength by preliminary tests, for greater control of concrete quality, and for a definite programme of on site tests of the deposited concrete. The stresses permitted are roughly 25 per cent. greater than for ordinary grade concrete and represent present-day practice in high-class concrete works. The third grade, or special grade, calls for greater exercise of control and more frequent testing. For this grade preliminary test results are made the basis of the working stresses, which may be as great as 25 per cent. greater than those permitted for high-grade concrete. Steel stresses have also been increased above those permitted by the present London County Council regulations provided certain conditions as regards yield point stress are satisfied.

New Shipbuilding Orders.

THE announcement is made that the Eagle Oil and Shipping Company, Ltd., of London, has placed with Tyne shipbuilders orders for two 11,000-ton deadweight carrying capacity motor tankers. One of the ships will be built by Swan, Hunter and Wigham Richardson, Ltd., at Wallsend, and the other by R. and W. Hawthorn, Leslie and Co., Ltd., at the Hebburn Yard. The single-screw oil engines for both ships are to be constructed at Hawthorn, Leslie's St. Peter's Works, Newcastle-upon-Tyne. The owners are also placing orders for four further ships, which contracts have still to be signed, and these are associated with the names of prominent shipbuilding yards on the Clyde, Tyne, and Tees. This important tanker order follows closely on that of the Anglo-Saxon Petroleum Company, of London, which was placed towards the end of last year and comprises twelve 12,100-ton motor tankers, each of which will be equipped with a single-acting four-stroke eight-cylinder engine, working with pressure charging, the pumps being arranged below the cylinders. These oil tankers, four of which are to be built in this country and eight on the Continent, will have a trial speed of 13 knots and a service speed of 12 knots. They will be constructed to designs and specifications prepared by Mr. C. Zulver, the owner's marine superintendent, and his staff.

The Steel Reorganisation Scheme.

THE progress of the scheme for the reorganisation of the steel industry has reached another stage by its circulation to the members of the National Federation of Iron and Steel Manufacturers. It is necessary that this body should approve it before it is presented to the Government. The first stage was its circulation in its completed form to the members of the National Committee, which had dealt with it through sub-committees, for its consideration, and the latter has now passed it on to the National Federation, which will discuss it at a meeting in February. There seem to be sharp differences of opinion in the steel trade regarding some of its provisions, but this is only natural considering the numerous interests which the scheme has been designed to reconcile. A few of the lighter branches of the trade are understood to be definitely opposed to certain features, but it is possible that these objections may be overcome. It is also understood that one or two sections of the industry have intimated that they do not propose to become parties to the scheme. On the other hand, strong support is forthcoming for the adoption of the Committee's plan in its entirety. There is a general deprecation of the suggestions which have appeared in some of the daily newspapers that compulsory powers may be sought to force reluctant members of the trade into the scheme. Few even of its strongest supporters would go so far as that in their desire to see it put into operation. An interesting feature which is much discussed is the proposal that the central organisation for conducting export sales should also be the central organisation for purchasing for the whole industry.

London's Water Supply.

AT the meeting of the Thames Conservancy Board, held on Monday last, January 8th, Lord Desborough, the Chairman of the Board, gave some interesting figures with regard to last year's rainfall and the water supply of London. The average rainfall for last year was, he said, remarkable. As recorded at twelve stations in the Thames Valley, it was approximately 22·7in., or the lowest, with the exception of 1921, for thirty-five years. The total fall in the Thames Valley was some 5¼in. below the standard average of 28·24in., but whereas the first six months showed an excess of 1·56in. above the standard monthly averages, the second half of the year was 7·1in. below the standard for the corresponding months. These months, with a total of 8·8in., marked the driest half-year since Conservancy records were begun in 1883. Notwithstanding the shortage of water, the flow and levels of the river Thames had been well maintained. The lowest monthly average was 371·6 million gallons in August. On Monday last the flow was 450 million gallons, compared with a standard daily flow for January of 2470 million gallons. Many inches of rain, Lord Desborough pointed out, will be needed to fill up deep-seated springs and chalk area wells. The general position of the London water supply was considered at a meeting of the Metropolitan Water Board, held to-day, Friday, January 12th. As a precautionary measure it will probably be necessary to install additional pumping plant to deliver more water from the west to the east of London, as the supplies available in the Thames Valley are more favourable than those of the Lea Valley.

The Development of the Parsons Steam Turbine.

No. II.

(*Continued from page 3, January 5th.*)

THE main features of the earliest Parsons turbine of 1884 have been described with considerable detail in order that the evolution of the invention may be more clearly followed. The years that followed the production of this machine were marked by continuous experimental work to increase efficiency and by untiring energy to establish the steam turbine as a reliable commercial prime mover. The leakage of steam past the blade tips owing to the clearance necessary between the fixed and moving parts was recognised as a serious source of loss. To minimise it the plan was tried of surrounding the blade tips by a continuous shrouding constructed in such a way as

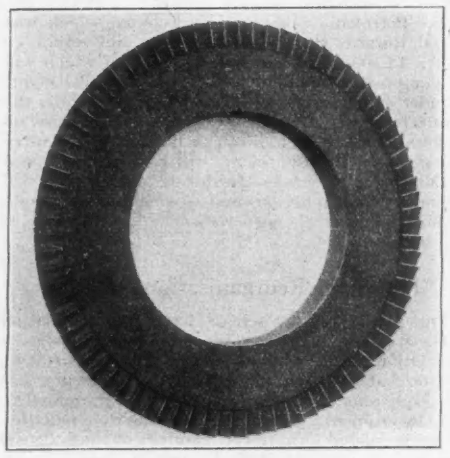


FIG. 3—BLADE RING

to baffle the leakage path. Every form of shrouding which seemed to promise useful results was thoroughly tested, and many were embodied in actual turbines, but experience seemed consistently to show that the benefit of any reduction in leakage due to the shrouding was neutralised by the extra skin friction involved.

FURTHER PROGRESS.

There were, however, other methods of improving the blading, and two notable advances were first embodied in a 32-kW turbo generating set constructed in 1888. The first consisted in curving the blades so as to direct the steam flow more efficiently than could be done by the flat blades hitherto used. The method of machining the blades from rings of solid metal, as employed in the original turbine, was retained, but the blades were undercut by a groove turned through their roots on the entrance side. The portion of the blade thus left overhanging was bent by pincers to the shape required. A blade ring formed in this manner is illustrated in Fig. 3. The second improvement lay in increasing the drum diameter by steps towards the ends, thus permitting a considerably increased area of steam flow without unduly lengthening the blades.

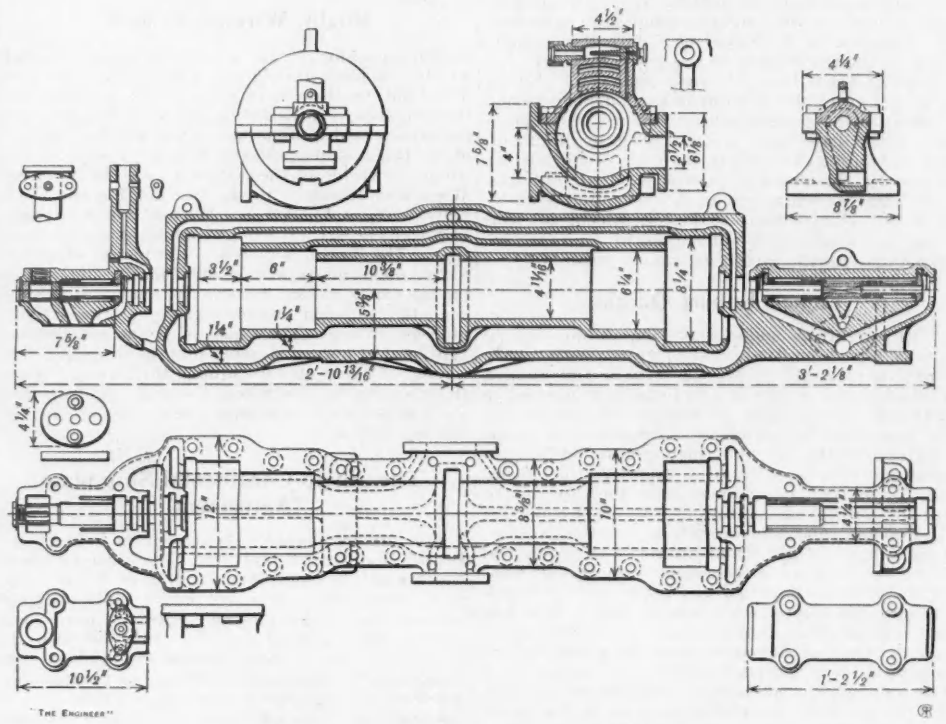


FIG. 5—DETAILS OF CASING OF 32-KW TURBINE SET

The double-flow principle was retained together with the systems of governing and of lubrication which characterised the pioneer machine. There was, however, one important constructional difference which had been found necessary at a very early stage. This was the rigid connection of the pedestals with the body of the turbine. In the first machine these were bolted independently to the bed-plate and difficulties were encountered by reason of the unequal expansion of turbine and bed-plate with changes of temperature. By casting the pedestals solid with the turbine casing they partook of its movements and the troubles ceased.

The general appearance of the 32-kW set is shown in Fig. 4. The rotor body was 39¾in. long, with diameters of 4 11/16 in., 6¼in., and 8¼in. over the blade tips. Balancing ports cast in the casing insured equality of steam pressure at points where the steam entered the intermediate and final sections respectively, and the exhaust ends were also connected by a balancing port. Still another port connected the leak-off chambers of the glands. This port was provided at the centre of its length with a discharge orifice fitted with a steam jet to give an ejector action. Details of the casing are given in Fig. 5.

The various improvements embodied in the design, together with the increase in size, enabled a steam consumption of about 58 lb. per kWh to be attained by machines of the type in question, when using saturated steam at a pressure of 100 lb. per square inch and working non-condensing. The type came into fairly extensive use for isolated lighting plants for shipboard and similar service. A popular unit was a 60-kW set running at 5000 revolutions per minute and delivering continuous current at 110 volts. The culminating point of the design may be said to have been reached in four 75-kW machines supplied to the Newcastle and District Electric Lighting Company, Ltd. The first set was delivered in 1888, only four years after the construction of the original 7·5-kW unit. It is famous as marking the earliest instance of the use of a steam turbine in any public power station. Its employment was a notable recognition by engineers of the turbine principle, and its success was the first step in the conquest of a field in which it is now absolutely indispensable. It is hardly too much to say that the development of the modern electrical industry dates from the enterprise of the Newcastle and District Electric Lighting Company in giving the steam turbine its chance in 1888. There is no need to labour the magnitude of this development, but it may be illustrated in a small way by comparing the order received by the Parsons Company in 1888, for a 75-kW machine, with the order given to them forty-two years later for three units of 50,000 kW each for the same city.

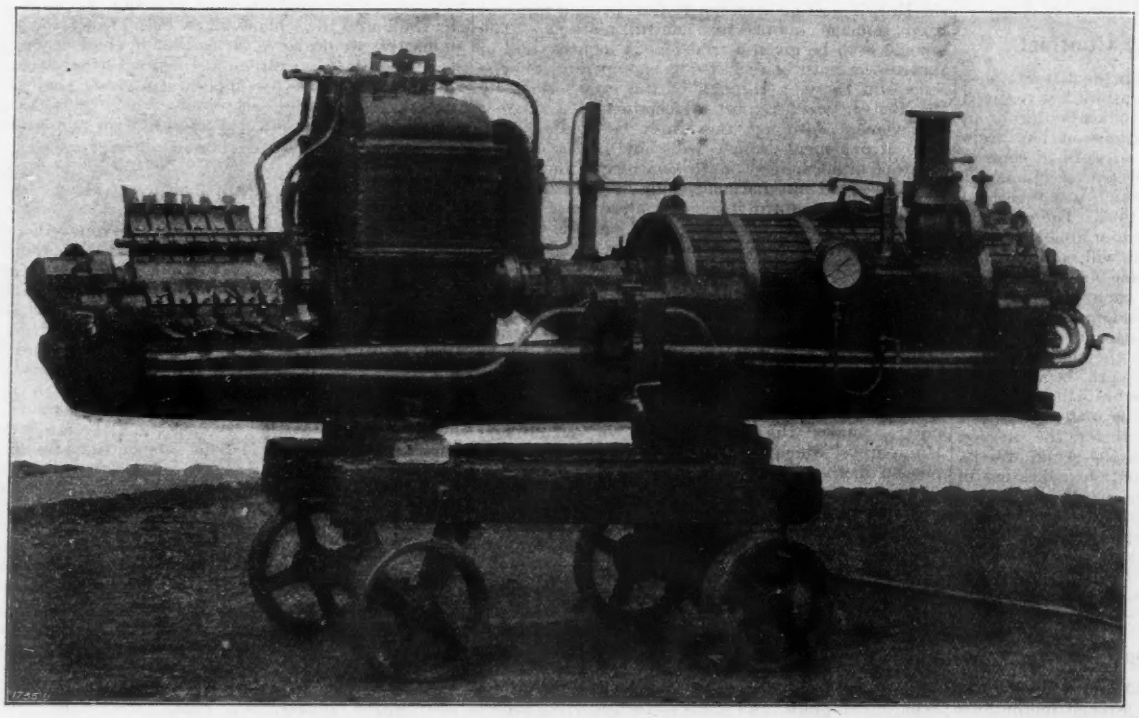


FIG. 4—32-KW PARSONS TURBINE SET

The turbine for the Newcastle Company was designed to work non-condensing, as were, indeed, all its predecessors. It was direct-coupled to a single-phase alternator supplying current at 1000 volts and 80 cycles, in accordance with the conditions of the

system. Exciting current was furnished by a dynamo coupled to the end of the alternator shaft, as is the general practice of to-day. The speed of the set was 4800 revolutions per minute.

Up to the year 1889, five years after the original invention, some 300 steam turbines had been constructed, the largest being the 75-kW size, of which a description has just been given. These machines may be taken as representing the highest development of steam turbine manufacture at the time, although designs for machines of a more ambitious nature, and notably for a compound unit with separate high and low-pressure cylinders in tandem on the same shaft had already been prepared. But then occurred an event which closed the first period of evolution, and for some years altered the whole course of turbine history. Differences of opinion arose between Mr. Parsons and his colleagues, resulting in Mr. Parsons' decision to terminate the partnership in 1889, and to undertake manufacture on his own account. The firm of Clarke, Chapman and Co., however, retained its rights in the use of the patents which Mr. Parsons had taken out whilst associated with it. Mr. Parsons therefore undertook not to manufacture a parallel-flow steam turbine of any kind, thereby surrendering the whole basis on which the normal development of his invention was founded.

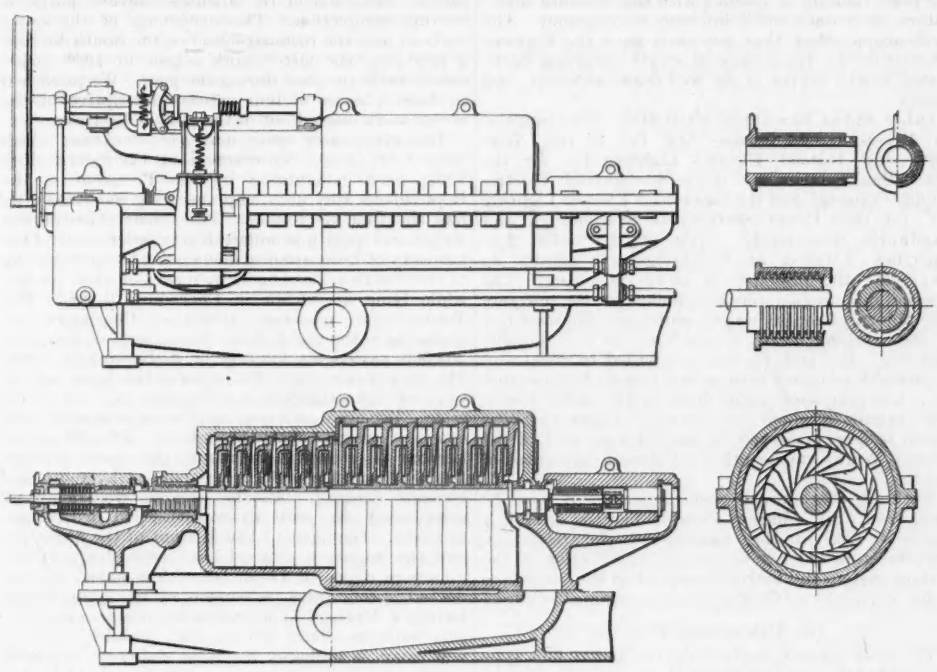


FIG. 6—ARRANGEMENT OF 32-KW RADIAL FLOW TURBINE

THE RADIAL FLOW TURBINE.

Such a check might well have been fatal. But Mr. Parsons was not to be beaten. If turbines embodying the flow of the steam parallel to the shaft could not be built, there was nothing to prevent the employment of a radial flow. Such an alternative was obviously inferior from the constructional point of view. It introduced new and difficult problems of design and rendered useless much of the experience so hardly earned. There was, nevertheless, nothing else to be done, if the manufacture of steam turbines was to continue, so the situation was met by Mr. Parsons with characteristic courage and energy. With the aid of friends he founded, in 1889, the firm of C. A. Parsons and Co., Ltd., which established the beginnings of the now famous Heaton Works at Newcastle-on-Tyne in the same year. Designs were immediately prepared for a turbine to work on the radial flow principle, and in accordance with them the new type of turbine was constructed before the year was out. This was a machine of 32-kW output, running at 6000 revolutions per minute. It was entirely different from anything which had been made before. The shaft carried thirteen brass wheels, the first six being of a smaller diameter than the remainder. On the "downstream" side of each wheel were cast curved brass vanes reaching from the periphery nearly to the centre. The casing was made with a horizontal joint, and divided into separate cells by diaphragms, also made in halves. The central part of each diaphragm was hollow, the internal space accommodating one of the wheels. The steam was led tangentially to the periphery of each wheel by guide ports in the surrounding diaphragms. It then flowed across one side of the wheel from circumference to centre, driving the wheel by its action on the vanes. It escaped from the chamber near the shaft, to travel outwards again to the ports in the succeeding diaphragm, and so on to the final exhaust. Each element of the whole turbine was therefore driven by an inward radial flow of the steam.

The turbine, which is illustrated in Figs. 6 to 9, was noteworthy as introducing for the first time several important details of design. Being a single-flow machine, some provision had to be made to avoid steam leakage around the shaft at the high-pressure end, and for this purpose the well-known labyrinth packing was invented. Again, the necessity of maintaining a fine axial clearance of the wheels in their chambers and the possibility of an unbalanced steam pressure acting longitudinally on the shaft, involved the fitting of a thrust block to maintain the shaft accurately in position. This was another innovation at the time. The bearings, too, were much improved and simplified. The flexibility and damping effect which had been obtained by the washer arrangement described in connection with the earliest turbine and used in all subsequent machines, was now secured by a different method. The washers had been found in time to cut and injure the sleeve of the bearing. They were replaced by three concentric tubes fitting loosely over the bearing sleeve. The lubricating oil finding its way between the tubes formed a perfect cushion, allowing any necessary displacement of the bearing to meet the needs of alignment, but damping out admirably all vibration. This type of bearing was used for very many years for high-speed machines, and is indeed still employed at the Heaton Works in the construction of centrifugal blowers and compressors which have a comparatively large shaft deflection and run at very high speeds.

A further new feature was the principle of "gust-governing," which characterised Parsons turbines for many years afterwards. The loss of control over his patents which had forced Mr. Parsons to produce the radial-flow turbine also prevented him from continuing the use of his previous system of governing. Hence he had to devise something different. He decided on adopting a centrifugal governor, a suitable speed for it, together with quietness of operation, being obtained by means of a friction reduction gear. The governor sleeve was formed as a cam, which, as it rotated, caused the closing and reopening of the throttle valve once per revolution of the governor spindle. The cam was so shaped that the axial sliding of the sleeve due to changes in the governor height affected the length of the period during which the throttle valve was held open. As the load increased the time of admission became longer and longer, until ultimately the valve was held continuously open. At normal speed steam was admitted to the turbine by a rapid succession of blasts or "gusts," hence the name of "gust governing" by which the system came to be known. It proved a perfectly satisfactory method of speed control, its principal merit being that the throttle valve and its mechanism were kept continually in motion and therefore "live," and so responsive to very small changes in the turbine speed.

Much important experimental work took place about this time with regard to the governing mechanism. Several forms of purely electrical governing were tried, one principle being to actuate the throttle valve by a solenoid which was excited for a longer or shorter period according to the position of a sliding cam which was in turn electrically controlled. Then an air relay system was introduced, a spring-loaded piston tending to close the governor valve against the action of air pressure admitted under the piston. The air was supplied by a reciprocating pump and governing was effected by regulating the air pressure. This was done by a solenoid, the plunger of which held open the suction valve of the compressor for a longer and longer period as the voltage across the machine terminals increased. If for any reason the current in the solenoid failed, the plunger was raised beyond its

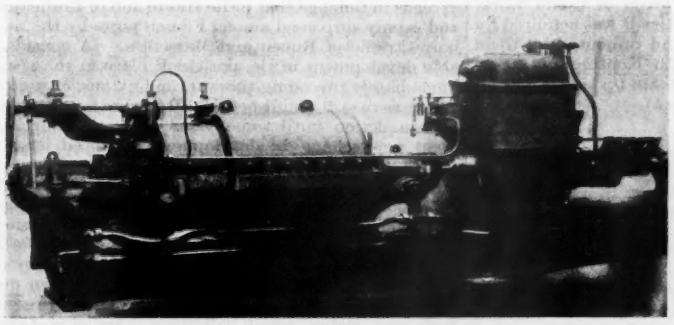


FIG. 7—EXTERNAL APPEARANCE OF RADIAL FLOW TURBINE

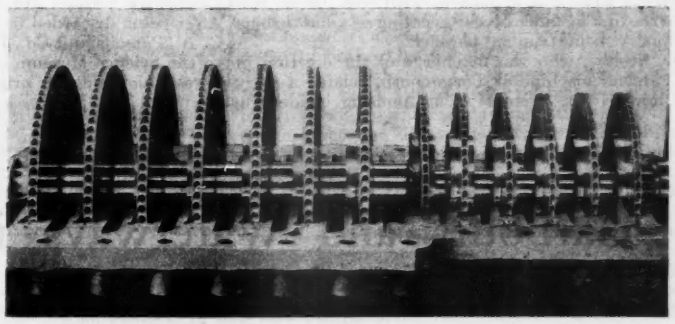


FIG. 8—WHEELS OF RADIAL FLOW TURBINE

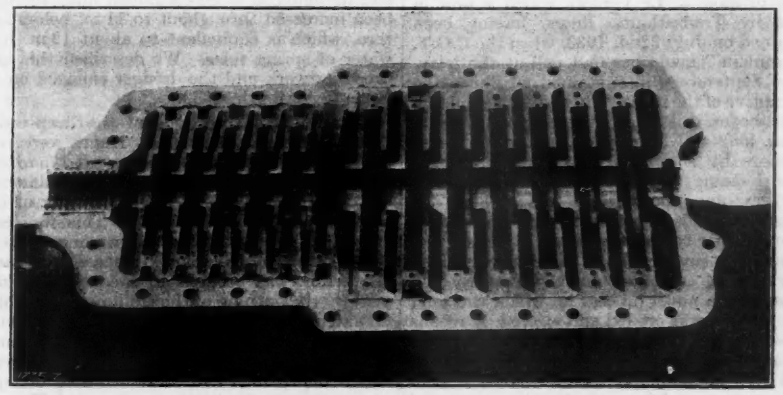


FIG. 9—HALF-CASING OF RADIAL FLOW TURBINE

neutral position by the action of a spring. Under such conditions the suction valve was also held open and the throttle valve was therefore kept shut by the spring pressure above the piston of the relay. The outcome of these and other experiments was the design of a governor gear in which the mechanical jogging action was reintroduced, together with a steam-operated relay and a solenoid control.

The principle of the inward flow was seen to be bad immediately the turbine was tested. Water and foreign matter, which found their way into the wheel chambers could hardly escape, the steam flow urging them inwards and centrifugal force having the opposite effect. The result was that the guide vanes were rapidly destroyed.

The inward radial flow principle having been found unsatisfactory for the reason stated above, the turbine was rebuilt to utilise the outward radial flow principle. The running blades, instead of having the form of long vanes, were narrowed down and greatly increased in number, so as to constitute a definite blade ring projecting from the face of each wheel. These changes resulted in a considerable increase of efficiency and held out promise of satisfactory development along the same lines. The next step was to employ three or four blade rings on the face of each wheel, alternating with rings of guide blades projecting from the adjacent diaphragm plate. Several turbines with such an arrangement were put into commercial use. The wheels at first were of brass with blades cut from the solid by a modification of the method used in the earlier parallel-flow turbines. The fixed blades were also cut from the solid out of brass rings which were attached afterwards to the diaphragms.

The largest turbine constructed on the radial flow principle was the machine of 2000 S.H.P. with which the famous vessel "Turbinia" was fitted in 1894. This turbine will be referred to later. Confining ourselves for the present to land practice, the largest radial flow turbine built was one of 150 kW capacity supplied in 1893 to the Portsmouth municipal electric light station. There were in the same station two 150 kW Yates and Thom slow speed reciprocating engines driving Ferranti alternators at 100 revs. per minute. These alternators were the first Ferranti machines with revolving fields. The Parsons turbo alternator had fixed ironclad field magnets and a surface wound armature about 12in. diameter and 3ft. 6in. long. It was similar in design to all the Parsons alternators of that period except that the frequency was 50 cycles instead of the more usual 80 or 90 cycles. The Ferranti alternators and the Parsons alternator were run in parallel with each other, this being the first instance of reciprocating sets and turbine machinery being run in parallel.

Dr. Stoney, who was in charge of the erection of the Parsons machine at Portsmouth, relates a story told him by Mr. Ferranti of an amusing incident in connection with the official opening of the plant. In the evening there was a municipal banquet and afterwards a number of the aldermen, councillors and guests went down to see the Power Station. The Ferranti alternators were supplying the town, while the station was lighted by arc lamps supplied by Parsons alternators. As the latter machine was not at the time running in parallel with the Ferranti alternators, there was a small difference of frequency. The stroboscopic effect thus produced gave the Ferranti alternators the appearance of slowly revolving backwards, to the horror of the well dined aldermen and others!

Other radial flow turbo alternators were supplied by Messrs. C. A. Parsons and Co. to the Newcastle and District Electric Lighting Co. for the Forth Banks station and to the Scarborough Electric Supply Company and the Cambridge Electric Lighting Co., for their Power Stations at Scarborough and Cambridge respectively. One of the radial flow machines installed at Cambridge was notable as employing the principle of steam jacketing. The internal diaphragms were cast hollow for the purpose. The object, of course, was to counteract the tendency of the working steam to condense on the metallic surfaces. The jackets, however, failed to effect any appreciable economy because any benefit derived from them was practically neutralised by the jacket losses. The turbine in which the principle of jacketing was tested is now preserved in the entrance hall of the Heaton Works among other interesting mementos of the firm's history.

Both at Scarborough and Cambridge it may be mentioned, Sir Charles Parsons had to accept a financial risk in the business of the respective companies, in order to secure the introduction of the turbine system and both companies had the advantage of his services as a Director for many years afterwards.

The Cambridge Turbine.

The most famous machine of the radial flow type was a 100 kW unit supplied to the Cambridge Electric Light Company in 1891. This turbine was notable for two reasons. It marked an epoch in turbine development by proving more economical in steam consumption than any reciprocating engine of equal capacity at the time, and it was also the first turbine to work condensing. By its economy of steam it provided the last and most conclusive proof of the advantages of the turbine for power station service, and consolidated the ground already won by reason of the economy of space and foundations, the silence, and the reliability established by its predecessors. The Cambridge turbine did many years of useful work. After being discarded from service it was acquired by C. A. Parsons and Co., Ltd., and presented by them to the Science Museum at South Kensington, where it rests alongside the original steam turbine of 1884.

(To be continued.)

Harbours and Waterways in 1933.

No. II.

(Concluded from page 21, January 5th.)

EUROPEAN PORTS AND WATERWAYS.

THE number of works of major importance brought to completion in French ports during the past year was unusually large. The completion of the deep-water mole at Le Verdon, near the mouth of the Gironde, the opening of the Transatlantic quay at Cherbourg, and the bringing into use of the last section of the deep-water quays at Le Havre, are among them. We have from time to time referred to the jetty or mole at Le Verdon, which is now in regular use by Transatlantic liners, having been officially opened on July 22nd, 1933, when the C.G.T. liner "Champlain" made her first call at the jetty. Our issue of September 1st contained an illustrated article descriptive of the work. The mole, the building of which was begun in 1929, is of reinforced concrete, about 317 m. long and 38 m. wide, and is connected with the shore by a curved viaduct. The superstructure of the mole has two decks, the upper carrying a roadway and the various services for the embarkation and disembarkation of passengers, while the lower floor carries the railway tracks. The superstructure is supported on hollow reinforced concrete cylindrical columns sunk in the sandy bed of the estuary by a novel process by which the sand inside the cylinders was eroded and ejected by means of compressed air. The process of sinking was usually so rapid that some of the cylinders, over 86ft. in length and 13ft. in diameter, with an enlarged bell-mouth foot, were towed from the building yard and sunk through the sand to the hard clay substratum in six to eight hours. The depth of water alongside the mole, which is 37 miles nearer the open sea than the quays at Bordeaux, varies from 43ft. to 50ft. at low water. The total cost of the works carried out at Le Verdon has exceeded 200 million francs.

Concurrently with the construction of the Le Verdon mole the Bordeaux Port Authority has carried out intensive dredging through the sand bar of the Gironde, employing a powerful suction dredger specially designed for work in a situation of considerable exposure. The dredging of the channel was begun in 1931, and by the summer of 1933 a depth of 10 m. below the lowest low water had been obtained in a new cut, over 3 kiloms. long, through the bar where formerly there was a depth of water of only 6 m. or 7 m. at low tide. The new channel when completed will have a minimum width of 1000 m., and dredging is to be continued until the depth has been increased throughout to 11 m. below low water zero, which is equivalent to about 12 m. below low water of spring tides. We described this important dredging work and the dredger engaged on it in our issue of April 7th, 1933.

Two important sections of the deep-water quay extensions in the port of Le Havre were completed during the year. The first is a quay, 175 m. in length, built between the western end of the Joannès-Couvert quay and the quays in the occupation of the Compagnie Industrielle Maritime. This was completed early in the year. The programme of deep-water quay construction embarked upon a few years ago by the C.I.M. was brought to a conclusion during the year by the opening of the Oblique Mole, which forms an extension westward of the Joannès-Couvert group of quays. The 175 metres quay, in common with all those forming part of the Joannès-Couvert group, has a depth of 12 m. at low water of equinoctial spring tides in the berths fronting it. The quay wall consists of hollow reinforced concrete caissons filled with sand after they had been sunk by compressed air. The Oblique Mole of the C.I.M., begun in 1931, is of similar design to the Quai Nord, belonging to the same company, completed in 1928. The depth of water in the berths on either side of the mole is 14 m. at equinoctial low water and its superstructure is carried on reinforced concrete piles, those at the front of the quay being enclosed within cylindrical reinforced concrete shells filled with concrete. The C.I.M. in the course of the summer also brought into use the second of the petroleum basins on the south side of the tidal harbour at Le Havre. The *gare maritime* of the Compagnie Générale Transatlantique, a huge structure mainly of reinforced concrete, which is in course of construction on the area behind the eastern extension of the Joannès-Couvert quays, is nearing completion. The deepening of the outer harbour and the reconstruction of the South Pier on a new site, the latter work begun in 1931, made considerable progress during the year. We published in June a series of four articles descriptive of the recent work carried out in the port of Le Havre.

The deep-water quay and *gare maritime* which have been under construction at Cherbourg since 1928, were inaugurated by the President of the Republic on July 30th, and the quay was named by him the Quai de France. The construction of this deep-water quay was undertaken in order to avoid the necessity of Transatlantic liners using the port having to transfer their passengers by means of small tenders while lying at anchor in Cherbourg Roads. The Transatlantic passenger traffic at Cherbourg has grown since the war to large dimensions, no less than 203,000 passengers landing or embarking in 1928. The deep-water quay, 620 m. long, has been built in front of and parallel to a previously existing rubble mole. The quay wall consists of a series of reinforced concrete caissons sunk through the soft bed of the harbour to a rock substratum, the space between this wall and the mole being spanned by reinforced concrete decking. All the caissons were sunk by compressed air and afterwards filled with mass concrete. The harbour bed in front of the quay wall and the approach channel have been dredged to a minimum depth of 11 m. below low water of equinoctial spring tides, a portion of the quay berths having a depth of 14 m. below low water zero. The *gare maritime*, built behind and parallel with the new quay, is probably the most elaborate and well-equipped building of its character yet constructed in any port used for the Transatlantic passenger trade. A second deep-water quay similar in character to the first was begun in 1931, and is still in course of construction. The Cherbourg port improvement works, when completed, will have cost approximately 230 millions of francs, over two-thirds of which sum has already been expended.

Dunkirk.

Another French port at which extensions on a large scale are in progress is Dunkirk, whose traffic already exceeds in tonnage that of Le Havre and of Bordeaux, and is only surpassed among French ports by the seaborne traffic of Rouen and Marseilles. A considerable development of the port took place in the years immediately preceding the war, and extension works, which were still unfinished in 1914, were not brought to completion until some years after the war. A great new scheme of development, financed largely out of German reparation payments, was initiated about three years ago, and consists of a seaward extension of the harbour combined with the construction of extensive basins inland and the necessary communicating passages. The existing East Jetty is being lengthened by about 700 m. A new jetty of solid construction, 750 m. long, is being thrown out from the sand dunes to the west of the present harbour entrance, which will, when completed, form, with the East Jetty, a new entrance, 270 m. wide, on the line of the natural deep-water channel that runs parallel with the coast and is sheltered by a stretch of sandbanks lying seaward of it. An entrance lock, 280 m. long by 40 m. wide internally, is in course of construction on the sand dunes, which will give access from the enlarged outer harbour to two new docks and a petroleum basin. Work on the lock and jetties is well advanced but three or four years must elapse before the whole of the scheme is completed and the docks brought into use. A large bucket dredger, "Pas de Calais II.," was brought into service at Dunkirk at the end of the year, and will be employed in connection with the dredging of the new entrance channel. It is capable of dredging to a depth of 75ft. below water level.

Marseilles.

The building at Marseilles of the great deep-water basin to be called the Bassin du Pharo, is proceeding steadily but slowly. The *bassin* will be protected by an outer breakwater over a mile in length, constructed in deep water, parts of which have already been raised above the surface of the sea and its quays will have a depth of not less than 45ft. of water alongside them. The construction of the Bassin du Pharo, including the equipment, is estimated to cost about 3½ million pounds gold. Work is also proceeding at the northern end of the Marseilles basins on the new Bassin Mirabeau, and the extension in a depth of water of about 100ft. of the breakwater which will protect it. In the construction of this breakwater cyclopean concrete blocks weighing 350 tons are being used. The estimated cost of the extensions at the northern end of the port is about 8 million pounds sterling.

The development of the Etang de Berre, the great inland deep-water lake lying to the north-west of Marseilles, is proceeding. A beginning has already been made with the construction of quays. The formation of a navigable entrance to the lake from the

Gulf of Fos is proposed, and, when such a channel has been provided, the land-locked water space of nearly 40,000 acres, most of which has a depth of water of more than 30ft., will be made available for overseas shipping and the lake may become a vast transhipment port, serving as a terminal of the main inland waterways of France. At present there is communication by way of the Rove Tunnel between the Marseilles basins and the Etang de Berre for barges of 600 tons carrying capacity.

The cessation of the supply by Germany of material on account of reparations has had the effect of slowing down the work on most of the French port extension schemes in progress at the present time, and the future of the vast works now in course of construction at such ports as Marseilles and Dunkirk is somewhat obscure. The French Under-Secretary of State for Public Works has stated that the completion of port and inland waterway works already in hand would involve an expenditure of 2800 million francs, to which the State is required to contribute one half.

The Seine.

We have made reference from time to time in these columns to the scheme for regulating and preventing floods of the river Seine by means of storage reservoirs in the Upper Seine Valley. The plan provides for two groups of reservoirs, the construction of which will be spread over a considerable period. The first of these reservoirs, the Crescent, the building of the dam for which was begun in 1929, was filled in October, and the building of the dam of the Bois-de-Chaumeçon reservoir was completed at the end of the year. Whether these reservoirs will prove entirely efficacious in preventing floods has yet to be seen, and it is not likely that anything further will be done towards the completion of the scheme until it is seen that the construction of the new dams is justified by the results obtained from the two first reservoirs.

Naples.

A work of much interest to harbour engineers was completed during the year at Naples. It is the island breakwater, 343 m. long, constructed to protect the western entrance to the harbour from the south and south-west. The whole of the breakwater is situated outside the 30 m. depth contour, the depth of water in which it is founded varying from about 100ft. to 137ft. at lowest water level. Three superimposed tiers of cyclopean concrete blocks, each weighing about 416 tons, form a vertical breakwater wall founded on a rubble mound at a level of 38ft. below the low water zero. The superstructure, mainly of mass concrete placed *in situ*, rises from the top of the block work, which is at low water level, to a height of 24ft. A good deal of newly built deep-water quayage at Naples was also brought into service during the year; practically all of the development at the eastern end of the harbour under the shelter of the Graneli Mole, which has been in progress since 1924, having been completed. It is intended to begin during the year 1934 the construction at Naples of a large dry dock, 321 m. long and 40 m. wide, in the entrance.

Genoa.

The underwater structure of the Principe Umberto Mole at Genoa was completed during the year, but the superstructure of the long westward extension remains to be built. The mole is an extension westward of the old Galliera Mole, the combined length of the breakwater thus formed being over 4000 m. The depth of water in which the mole has been built varies between 15 m. and 20 m. The structure comprises a rubble mound with vertical wall of cyclopean blocks and a mass concrete superstructure similar to the island breakwater at Naples. Two of the piers or jetties in the Mussolini Basin, which is sheltered by the western extensions of the Umberto Mole, are approaching completion, and early in the year a contract was let for the building of additional quays in the basin.

Other Ports.

The port of Gdynia, which Poland has constructed on the shores of the Baltic, a few miles west of Danzig, has already been in use for several years, and its export of coal now exceeds that of any other Baltic port. The original scheme of works was brought to completion, and a ceremony of inauguration took place on December 8th, when the new passenger station, several transit sheds, and the free zone in the port were formally opened.

The most important event of the year in Holland to be recorded in this review was the official inauguration of the great dyke enclosing the Zuider Zee reclamation, which is now open to road traffic from New Holland to Friesland. The ceremony took place on September 25th. The north-western, or Wieringermeer Polder, is already under cultivation. It will be remembered that the construction of the main dyke was begun in 1927, and that the barrier was closed in May, 1932; it has a length of about 18½ miles.

A year ago we stated that the canal which the Soviet Government is making between the White Sea and the Baltic was approaching completion. It is reported that this canal was officially opened in the summer, although dredging is said to be still in progress in many of the lakes and channels which constitute the waterway. It is reported that about 50,000 men were mobilised to carry out the project.

A proposal to construct a canal from the Gulf of Finland to Lake Lagoda at a cost of over £3,000,000 is under consideration by the Government of Finland.

AFRICA.

One section of the first quay to be built in the new harbour of Port Elizabeth was formally opened on October 28th. The only accommodation for shipping hitherto available in Algoa Bay has been the open roadstead and a couple of jetties thrown out from the shore which provide berthage for barges. All ocean-going vessels loaded and discharged their cargoes by means of lighters in the roadstead. The new work is named the Malan Quay, and runs out from the shore in an easterly direction for 2000ft. It will, when finished, provide berthage for four ships. Beyond its end a rubble mole will extend for a further 1550ft. The first of the deep-water berths to be completed was occupied by H.M.S. "Dorsetshire" on the occasion of the opening ceremony in October. It will be three years before the whole of the 2000ft. of quayage is ready for use, and as yet that part of the quay already completed is unequipped with cranes. The Malan Quay and the rubble mole in extension of it form together the north arm of the harbour. The curved breakwater on the other side of the harbour, 4850ft. long, has been completed, and work has been commenced on the No. 2 Quay, which will be parallel with the Malan Quay. When the port works at present contemplated are completed, the total expenditure will have been in the neighbourhood of 3½ million pounds.

Among French Colonial ports, Casablanca is carrying out further extensions of some magnitude in spite of the depression which has resulted in a considerable falling off of its trade. The breakwater, which has already been constructed to a length of 2400 m., is to be extended a further 350 m. The equipment of the new Commercial Jetty, a structure 220 m. wide, and one of the latest internal works to be built in the port, is in progress, and twenty 5-ton electric cranes are being erected on the quay which forms its eastern side. Grain elevators of 30,000 tons capacity and a coaling wharf are also being built at the port. The Colonial Government of Morocco also proposes to spend large sums on port works at Rabat-Sale and Mehedya. The French Colonial Government of Madagascar has decided to spend 70 million francs on the construction of a mole at the port of Majunga. The new port of Pointe-Noire, on the Atlantic Coast of French Equatorial Africa, is expected to be opened for traffic some time in 1934.

THE EAST.

The harbour of Haifa was formally opened by the High Commissioner for Palestine on October 31st. At a cost of over 1¼ million pounds, a sheltered harbour of approximately 300 acres has been formed by the construction of two breakwaters of rubble stone thrown out from the shore at the southern end of the Bay of Acre. The roadstead is here sheltered from westerly winds by the promontory of Mount Carmel. A large part of the sheltered water area in the harbour has been dredged to a depth of over 11 m., and 2200ft. of quayage have been constructed, of which 1400ft. provide deep-water berthage. An illustrated article descriptive of the harbour works appeared in the pages of this journal on November 3rd last.

The harbour of Vizagapatam, on the east side of the Indian peninsula, was formally opened by the Viceroy, Lord Willingdon, on December 19th. The harbour works, which have been in progress for several years, were undertaken with the object of providing a port capable of receiving overseas shipping at some point on the long coast line extending from Calcutta to Madras, which has hitherto lacked any harbour of major importance. The harbour now provides a sheltered water area, having a depth over a large part of it of 30ft., with three berths alongside quays, in addition to berths at buoys in the dredged channel. Concurrently with the construction of the port works, the Bengal and Nagpur Railway Company has built a new branch line linking Vizagapatam with Raipur in the Central Provinces, thus providing a shorter route for traffic between the new port and Central India. We have frequently made reference to the interesting dredging operations on the bar at Cochin on the Malabar coast, which have converted an almost land-locked backwater into a useful harbour for deep-draught vessels. The further development of the port is under consideration, and it is expected that the construction of quays will be begun shortly. This will enable ships which at present lie in the lagoon channel to discharge their cargoes direct into railway wagons or transit sheds.

The Navy Estimates for 1933–34 indicated that something like 5 million pounds had up to the end of the last financial year been spent or voted in connection with the Singapore base. It is expected that the main contract, placed with Sir John Jackson, Ltd., in September, 1929, will be completed by September, 1935, but about two years more will be required for the equipment of the base and the completion of the machinery installation. Thus it is unlikely that the naval base will be ready for full use until the end of 1937.

It is reported that the Japanese contemplate the construction of port works on a large scale at Rashin, on the Korean coast. An expenditure of 40 million yen spread over a period of twelve years is proposed. The intended expenditure at Rashin, which will serve the northern part of Manchuria, may be compared with the cost of the port works at Dairen, which is still the principal port of Manchuria, on which it is said some 60 million yen have been spent.

It will be remembered that the great earthquake of February, 1931, caused the upheaval of the harbour bed at Napier, in New Zealand, by some 7ft., the physical conditions of Hawke's Bay being at the same time radically changed in the neighbourhood of the breakwaters. A development scheme for the remodelling of the port works has now been approved, the estimated expenditure being about £400,000.

NORTH AMERICA.

The damage done by the disastrous fire which destroyed the greater part of the port warehouses and quayage at St. Johns, New Brunswick, in 1930, has been more than made good by the works since carried out by the Harbour Commissioners. The reconstructed shipping berths and the additional berths which have been provided afford a depth of at least 30ft. of water at low water. At the same time the approach to the harbour has been improved by dredging. New grain elevators have been erected, one of which has a capacity of 1½ million bushels. Work upon two transit sheds, each 95ft. in width, one 600ft. and the other 740ft. long, is still in progress. The most important of the new works built since the fire is a pier 700ft. long by 300ft. wide, which, with the quay walls adjoining it, provides some 3000ft. of quayage. The construction of these works was carried out in the dry within a cofferdam of steel sheet piling, which is said to have been the largest cofferdam ever made in connection with dock or harbour works. It had a perimeter of 5890ft., and enclosed an area of 43 acres. The removal of the cofferdam was begun early in the year on the completion of the building of the pier structure.

The latest development at Halifax is the completion of Pier B in the deep-water extension of the port known as Ocean Terminals. This pier is 1250ft. long, 300ft. wide, and is of concrete crib construction. The berths have 45ft. depth of water at low water. The sheds with which Pier B is to be equipped are not yet erected.

Work on the deepening of the St. Lawrence channel continues. The objective of the river improvements is to provide a channel with a minimum depth of 35ft. up to Montreal. The engineers responsible for the work have stated that the total volume of material which will have to be removed from the channel between Montreal and the sea in order to complete the 35ft. project is upwards of 127 million cubic yards.

In spite of the world trade depression, there seems to be no abatement in the rate of increase of appliances for grain storage and shipment in Canadian ports. The Montreal harbour elevators delivered during the 1932 season approximately 113 million bushels, an increase of over 23 million bushels compared with the season of 1931. Nearly all this grain was exported overseas. The port of Sorel, 45 miles below Montreal, is increasing its grain storage, and the capacity of one elevator alone is being brought up to 4 million bushels by building an extension to the present structure. The new port of Churchill, on the southern shore of Hudson Bay, was closed for the winter on October 2nd. During the summer season over 3 million bushels of wheat had been shipped at the port. Several extensions to the various grain storage units at Vancouver have increased the total capacity for storage in that port during the year by over 2 million bushels. The grain shipments at Vancouver in 1932—the last year for which complete figures are available—totalled 105 million bushels. At Vancouver, also, an extension to the Lapointe Pier, 300ft. in length, begun over a year ago, was completed.

The deepening of the various ship channels in the harbour of New York continues to monopolise the work of a large part of the dredging fleet controlled by the United States Army Corps of Engineers. This federal service is now spending something like one million pounds annually on the programme of dredging and rock excavation in the harbour of New York, one item of which is the dredging of the Hudson River from deep water off Ellis Island up to Twentieth-street, Manhattan, to a low water depth of 40ft. between the pierhead lines.

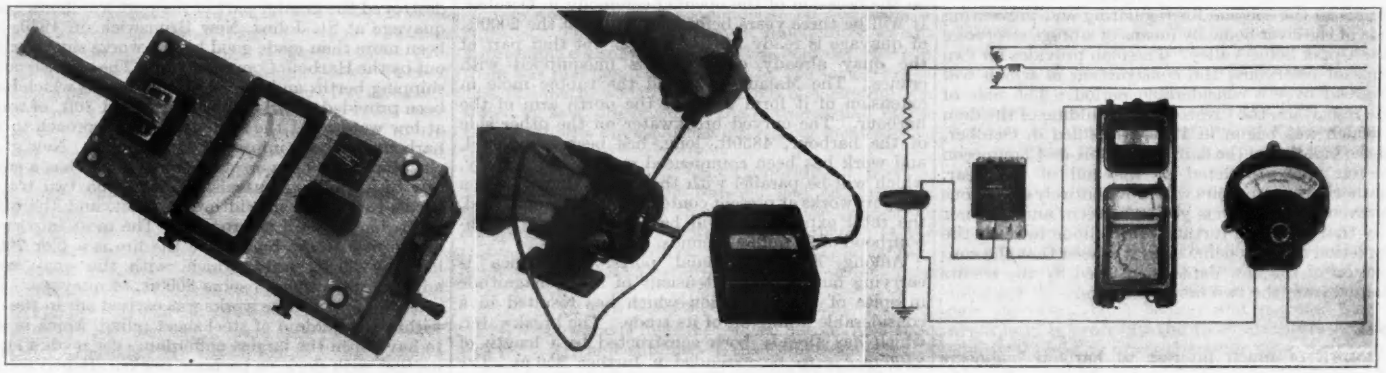
AN irrigation scheme and power project, which will bring under cultivation about 225,000 acres of waste land, and provide 9000 H.P. of electrical energy, is under consideration by the Mysore Durbar, states the *Electrical Review*. The scheme, which is known as the Lakavalli Reservoir project, will, when completed, be one of the biggest of its kind in the country and the height of the dam wall will be greater than that of the Krishnaraja Sagara. The dam will be 3200ft. in length and the depth of the water stored will be 180ft.

The Physical Society's Exhibition.

No. I.

MANY instruments and ingenious pieces of apparatus for a wide variety of purposes and representing the latest achievements of instrument designers and scientific workers in general, were to be seen at the Physical Society's twenty-fourth annual Exhibition, held at the Imperial College of Science and Technology, South Kensington, from Tuesday to Thursday of this week. The trade and research sections were as attractive and instructive as ever, or, perhaps, even more so. Research work undertaken in laboratories, such as those of the British Thomson-Houston and General Electric companies, has led to the introduction of many useful and fascinating things, which are to be seen from year to year at this Exhibition. An outstanding feature on this occasion was a number of devices designed to show the varied uses of photo-electric cells and cathode ray tubes, including a tube used as a relay which picks out points on a current or voltage wave near the zero value.

Although electrical exhibits again out-numbered other exhibits, many things which have no connection with electricity were, of course, on view. The section of the Exhibition devoted to the work of apprentices and learners in the employ of exhibiting firms contained some fine examples of craftsmanship and draughtsmanship relating to the scientific instrument trade. Another feature well appreciated was the usual series of experimental discourses delivered on this occasion by Mr. R. S. Whipple, Mr. J. Guild, and Sir Ambrose Fleming, who dealt with "The Evolution of the Galvanometer," "The Instrumental Side of Calorimetry," and "The History and Development of the Thermionic Valve" respectively.



FIGS. 1 TO 3—CAPACITY AND RESISTANCE TESTING INSTRUMENTS AND CURRENT LEAKAGE RECORDER

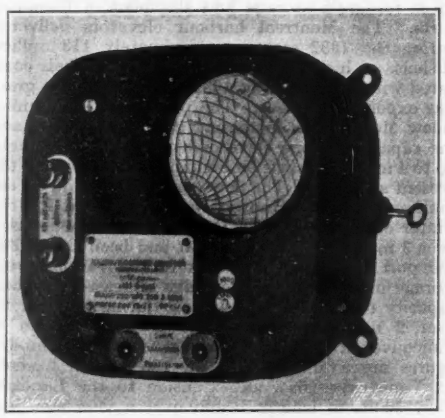


FIG. 4—RECORDING AMMETER

Following our usual practice, we shall confine ourselves mainly to some of the outstanding exhibits of firms engaged in the business of meeting engineering requirements. Among the electrical instrument firms exhibiting was that of Evershed and Vignoles, of Acton-lane Works, Chiswick, which was showing, among many other things, the Megger capacity meter, illustrated in Fig. 1. It is similar to the firm's Megger sets for measuring resistance, and the reading it gives are independent of voltage and frequency. A low ohmic resistance in parallel with the capacity under test is also said to have no adverse effect on the reading. One instrument exhibited has four ranges—0–0·3, 0–3 and 0–10 microfarads. A workshop type of capacity meter is designed to take its supply from A.C. mains instead of from the hand-operated A.C. generator incorporated in the instrument illustrated in Fig. 1. The new recording Megger insulation tester, described in our issue of December 29th, was another Evershed and Vignoles exhibit.

The Megger circuit tester shown in Fig. 2 is a development of the "Wee Megger" tester, which we have also described. It is designed for tracing circuits in the case of breakdown, for the rapid location of trouble, or for the measurement of conductor resistance. Equipped with the same kind of movement as used in the "Wee Megger" tester, the instrument is unaffected by voltage variations. In place of the usual generator a flat type of $4\frac{1}{2}$-volt dry battery, obtainable almost anywhere, is provided. Two types of these instruments are available for low and high resistances respectively, and covering between them the measurement of resistances of a few ohms up to 200,000 ohms. Spring-operated plunger terminals are provided, together with a press-button switch for use when taking a reading so as to prolong the battery life, although, if desired, the instrument can be supplied with testing spikes with the switch embodied in the handle of one of them.

Leakage indicators and recorders used on electrical systems have always been liable to damage as the result of a high current passing through the neutral conductor when a breakdown occurs. In general, a relay has, therefore, been provided to protect the instruments against even a momentary rush of current by inserting a limiting resistance, or by short-circuiting the instrument when a fault occurred. Experience has shown, however, that the action of the circuit breaker is often insufficiently rapid to prevent damage to the instrument, which, naturally, remains inoperative until the relay is reset. In the Knowles-Shotter instrument shown in Fig. 3, however, use is made of the characteristics of mumetal. The moving coil, rectifier-operated indicator or recorder is connected to a transformer and to a reactor, and the transformer core becomes saturated when the leakage current reaches 10 ampères. Any increase in this current has practically no effect on the secondary current, and, consequently, no harm can come to the instrument. A momentary short circuit passes without damage, and the instrument is immediately ready again to record small variations in leakage current.

A maximum-demand recording ammeter (Fig. 4) for A.C., 50-cycle systems, was one of the exhibits of Elliot Bros. (London), Ltd., of Century Works, Lewisham. It is designed to give a record of current over a period, and is particularly suitable for use in places in which space is limited, such as in transformer chambers, &c. The instrument is of the "inkless" type, the record consisting of a series of dots closely adjacent to each other, and produced by the periodic pressure of the pointer tip on the surface of the specially prepared chart paper, the length of the scale being 2·3in. The chart is in the form of a disc and has a nearly linear graduation down to $^1/_{10}$ of the maximum scale deflection, and is calibrated with a percentage scale of 0–100 per cent.

Primarily the instrument is intended for use in conjunction with the Shotter patented split-core current transformers, which are supplied in the clamp and scissor types, suitable for embracing a cable carrying A.C. and enabling measurements and records to be made of the current passing without breaking the circuit. The transformers may be at a considerable distance from the recording instrument, and several ranges can be obtained by adjusting the core air gap. Provision is made, however, for operating the instrument from an ordinary current transformer with a standard secondary current of 5 ampères. The D.C. rectifier-operated moving coil movement gives a maximum scale deflection for 40 milli-ampères A.C. The chart is driven by a small self-contained, self-starting synchronous clock motor, and makes one complete revolution in seven days. A record is made every fifteen minutes. The resultant chart obtained gives the current variations throughout each twenty-four hours for one week, and by leaving the instrument in circuit for longer periods the daily records are superimposed on one another and the average demand at any instant and for any length of time can be ascertained. An important use to which the instrument lends itself is that of recording the load fluctuations of feeders, &c.

The Siemens cross filament pyrometer was another outstanding exhibit on Elliott Brothers' stand, but as it was described in our issue of September 8th it does not call for attention here. The 2in. round and edgewise miniature switchboard, volt and ammeters, shown in Fig. 5, however, deserve a few words. They represent the smallest of the firm's D.C. instruments, and have a guaranteed accuracy in accordance with British Standards Specification No. 89 for first-grade instruments. The makers are anxious that they should not be confused with the lower-priced instruments working on the moving iron principle. They are claimed to have an almost universal application in connection with the accurate measurement of D.C., and are particularly suitable for mounting on a small panel for general D.C. measurements. They offer the obvious advantage of saving space. Other advantages are small consumption and low weight. They are supplied as ammeters for ordinary measurements or as milli-ammeters, and have many applications in connection with testing equipments, wireless work, motor cars, aeronautics, and so forth. Instruments are also supplied as cell testing voltmeters, with testing spikes. The movement consists of a moving coil rotating in the field of a permanent magnet, and is similar to that of more standard moving coil instruments. While the round instruments have black Bakelite cases, those of the edgewise instruments are made in four colours—black, mottled red, mottled green, and plain brown.

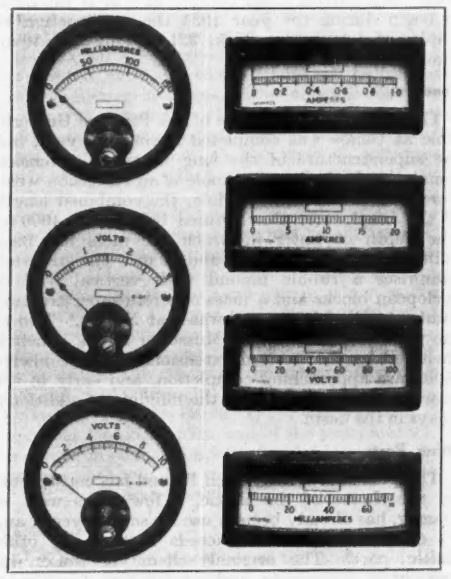


FIG. 5—MINIATURE VOLT AND AMMETERS

Perhaps the most important exhibit from an engineering point of view shown by the research and experimental section of the British Thomson-Houston Company was a thyratron controlled spot welder. It is sometimes desired in welding operations to limit the duration of the welding impulse to one or a few cycles of the A.C. at commercial frequencies. When making welds between dissimilar metals or between similar metals, such as stainless steel, or when it is desired to adopt high-speed welding, short-time current impulses are requisite. When the duration of the current flow is controlled mechanically, however, and especially when the timing is left to the discretion of operators, uniformity cannot be secured. But experience has shown that for seam or spot weld-

ing, the thyratron gives uniform control and permits high-speed working with precision timing.

At the Exhibition thyratron control was applied to a small pedal operated 1-kVA spot welder, as used in the manufacture of electric lamps, wireless valves, &c. When the operator closes the control contacts only one welding impulse of predetermined duration occurs, irrespective of how long the contacts remain closed. As the thyratron is a high-voltage, low-current device, a circuit similar to that shown in Fig. 6 may be used. The thyratrons are arranged to pass both halves of the A.C. waves, and are coupled to the line through a step-up transformer, termed a series reactance transformer. When the thyratrons are non-conductive the secondary of this transformer is open-circuited, and if the welding electrodes are closed the current is limited to a negligible value by the open-circuit impedance of the series transformer. But when the thyratrons are made conducting the series reactance transformer is in effect short circuited. Assuming the short-circuit impedance of the transformer to be 5 per cent., a voltage in the neighbourhood of 95 per cent. of the line voltage is impressed on the primary of the welding transformer, and a weld is produced. As long as the grid of a thyratron is kept more negative than the critical voltage which is a function of the anode voltage, the arc cannot strike. When once the arc has been established, however, the grid has no further control, and the arc continues until the anode voltage falls substantially to zero, or becomes negative—*i.e.*, until the end of the positive wave in the case of an A.C. supply. Thus, in the case of tubes in which the critical voltage is negative, the current can be started and stopped by applying a suitable positive or negative voltage to the grid. Stopping the current, of course, implies pre-

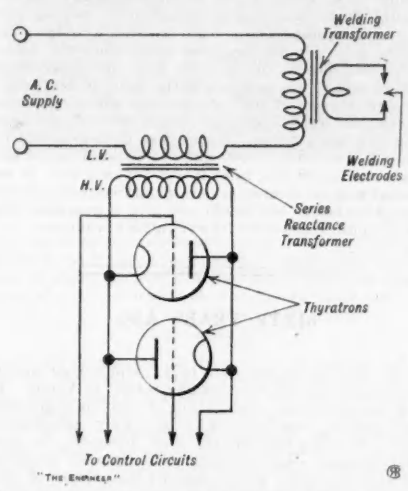


FIG. 6—THYRATRON CONTROLLED SPOT WELDER

venting it from restarting at the next positive half-cycle.

Two methods of grid control are commonly employed. In one case an alternating voltage is applied to the grid and its phase displacement is varied relatively to the anode voltage. The phase of the grid voltages can be varied by means of a bridge circuit, the phase change being effected by short-circuiting one element of the bridge by a cam-operated contact. The alternative method is to apply to the grid a steady negative voltage bias which normally prevents the arc striking and to superimpose upon it, when the thyratron is required to pass current, either an A.C. voltage in phase with the anode voltage, or a positive voltage transient of sufficiently long duration to maintain the thyratron conducting for the required time.

Another B.T.H. exhibit was a simple radiation relay which closes a contact in an electrical circuit when radiation reaches it, and reopens the contact when the radiation is removed. It consists of two similar bi-metallic strips, one blackened and the other polished, the former being exposed to radiation. The difference of temperature set up by the radiation is sufficient to cause the gap at the free ends to close, although changes of ambient temperature, affecting each strip similarly, leave the gap substantially unchanged. The relay used was shown operating in a circuit including a synchronous electric clock, the period of running of which records the life of an electric lamp under special test conditions, which necessitate the accurate recording of the running time without affecting the lamp-operating circuit. A relay was also shown connected in series with an electric lamp. The radiation from the lamp causes the contacts to open and to extinguish the light when the contacts are closed again, the result being that the lamp is made to flicker.

The air/gas ratio apparatus, shown in Fig. 7, was one of the many exhibits of the Cambridge Instrument Company, of Cambridge. It is for measuring accurately and rapidly the percentage by volume of a gas in air, and although it is primarily intended for use with coal gas, it can deal with most other gases mixed with air. The apparatus works on the thermal conductivity principle, and measures, on the one hand, the difference between the thermal conductivity of the pure gas and that of air, and, on the other, the difference between the thermal conductivity of the gas mixture and that of air. From these two measurements it is possible to obtain the composition of the gas mixture. Two types of this instrument are available, both of which are self-contained, and include the meter for measuring thermal conductivity and a galvanometer which indicates the gas composition. The pure gas is passed through the instrument and the galvanometer set to read 100 per cent. The pure gas is then disconnected and the instrument is

FIG. 7—GAS-TESTING APPARATUS

connected to the gas mixture to be analysed, when the reading falls and shows the composition of the gas mixture. To increase the accuracy of reading, the instrument can be fitted with more than one range. In the portable instrument shown in Fig. 7, a supply of pure gas is connected to one of the arms of the three-way tap A and the mixture to the other arm. If the gas is under pressure it is led to waste at B. If under suction, some form of aspirator must be attached to B. Electric current for working the meter is obtained from dry cells contained in the lid of the case. The instrument can be provided with

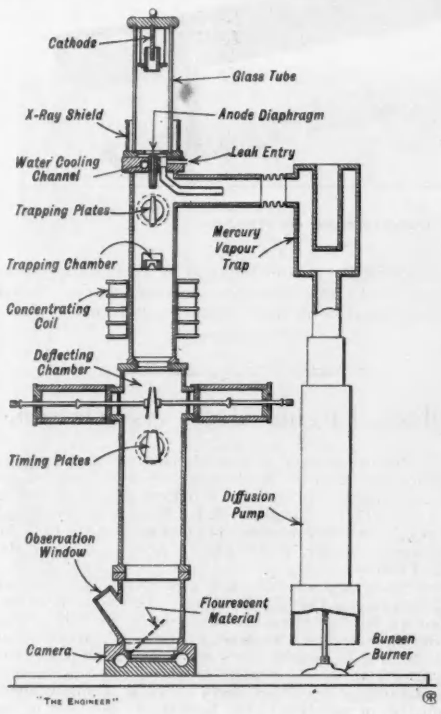


FIG. 8—SECTION THROUGH CATHODE RAY OSCILLOGRAPH

three ranges, the change from one range to another being made by the plug-and-socket switch at C. The switch at D, with a "test" position, is for use with a calibration curve when a high degree of accuracy is required when testing gases of very variable composition.

A high-speed cathode ray oscillograph, shown by the Cambridge Instrument Company, of Cambridge, permits of the distortionless recording of transients having a total duration of less than the hundredth part of one micro-second. It is of the cold cathode type, the cathode beam being generated by the bombardment of the cathode by positively charged particles. The cathode, situated at the upper end of the tube—Figs. 8 and 9—is maintained at a potential of 10–70 kV negative with respect to the anode, which is usually earthed. The anode is pierced with a small hole or diaphragm, and that portion of the discharge passing through this orifice forms the cathode ray beam which is concentrated magnetically and brought to a sharp focus on a photographic plate or film, or on a fluorescent screen in the camera situated at the base of the instrument. During its passage from the anode to screen or film the beam passes between the two pairs of deflecting plates set at right angles in the deflecting chamber. Potentials applied to these plates deflect the beam, the deflection on the screen being directly proportional to the applied voltage, and since the deflection is electrostatic, the loading on any circuit under test is negligible.

The oscillograph is composed of four sections—the cathode or discharge chamber, the pre-deflection chamber, containing a beam trap device, the deflection chamber, and the camera. With the exception of the glass tube of the cathode chamber the oscillograph is constructed entirely of metal, and by unscrewing a single ring the deflection section may be removed and an electron diffraction chamber inserted. This chamber contains a specimen carrier for use with solids, thin films, &c. Provision is made for diffraction through gases. A port is also provided to carry a heating filament, so that metallic surfaces may be prepared *in situ*. The discharge chamber consists of a glass tube supporting at one end a heavy metal flange carrying an aluminium rod which forms the cathode. This rod has a removable tip so that when, after long use, the cathode surface becomes pitted another tip may be fitted in a few minutes. Round

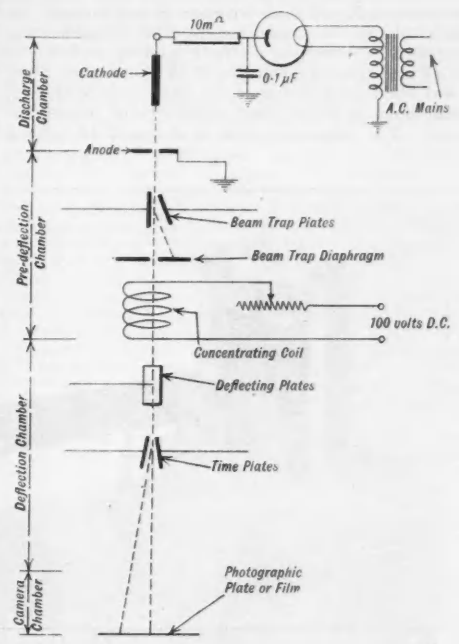


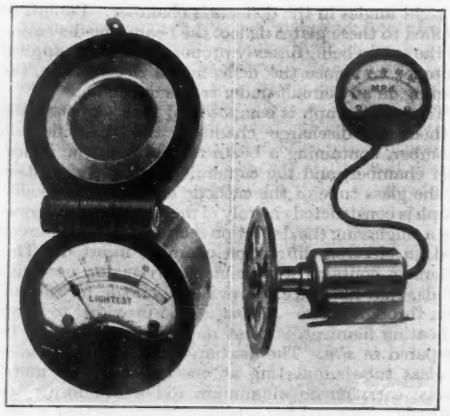
FIG. 9—DETAILS OF CATHODE RAY OSCILLOGRAPH

the cathode there is an aluminium cylinder, the potential of which serves to concentrate the beam electrostatically. The cathode is maintained at 10–70 kV negative with regard to the remainder of the tube, which is at earth potential. The discharge chamber is situated at the top of the "anode block" at the upper end of the deflection chamber. This block, which is water cooled, holds the anode diaphragm in a removable taper plug. The size of the aperture selected depends largely on the speed at which the instrument is required to work. Air may be slowly admitted through the air leak shown in Fig. 8 to the discharge chamber to maintain the correct degree of vacuum for the gas discharge forming the beam. A tube which leads into the main evacuation pipe of the oscillograph serves to evacuate the discharge chamber and acts as an "injector." The velocity of air passing down the tube is great compared with the flow in the main evacuation pipe, and any mercury vapour tending to diffuse through to the apparatus from the pump is thus driven back. A butterfly valve in the opening to this injector tube, and situated in the anode block, enables a fine control of the gas pressure to be obtained in the discharge.

In this section of the apparatus there is also a "beam trap" or relay for withholding the beam from the photographic film until the actual photograph is taken, thus avoiding fogging. The trap consists of a pair of deflecting plates with a diaphragm below them, as shown in Fig. 9. When the deflecting plates are at earth potential the beam passes between them and through the hole in the diaphragm to the screen. If, however, a potential be applied to one plate, the beam is drawn aside and is arrested by the diaphragm and does not reach the screen or photographic plate. In practice the trap circuit is so arranged that the random transient to be recorded releases the beam, and when the spot actuated by the time sweep plates

has traversed the photographic plate it is automatically withdrawn again. A concentrating coil carried on levelling screws surrounds this section, and when supplied with a direct current of about 0·15 ampère at 100 volts serves to concentrate and focus the electron beam in the manner of a bi-convex lens.

The deflection chamber is clamped in position below the pre-deflection chamber, and contains the two pairs of aluminium deflecting electrodes carried on double-sheathed transparent quartz tubes,



FIGS. 10 AND 11—ILLUMINATION METER AND TACHOMETER

mounted on Mycalex discs cemented into ports in the main tube of the oscillograph. The electrodes are insulated to withstand a steady applied potential of 40 kV and transient voltages of 60 kV. By warming a wax seal the separation of the plates may be altered, thus changing the voltage sensitivity of the instrument. The camera section is designed to take a 6 cm. by 9 cm. plate or ordinary eight-exposure roll film.

Rectified current at from 10–70 kV supplied from a transformer and high-tension rectifying valve is used for operating the tube. For steady operation a smoothing condenser of about 0·1 μ F is connected across the rectified outfit to earth, and a limiting resistance of about 10 megohms, or preferably a rectifying valve run under saturation conditions, is employed to connect the smoothing condenser to the oscillograph cathode. The tube is evacuated by either a three or four-stage mercury vapour diffusion pump backed to a few millimetres of mercury by a small oil-sealed rotary pump, and a mercury vapour trap is included in the evacuation system.

Many useful electrical instruments, including metal rectifier instruments for A.C. measurements, were shown by Salford Electrical Instruments, Ltd., of Pell Works, Silk-street, Salford, Lancs. Portable illumination meters utilising a new type of photo cell of large capacity, which does not necessitate the use of batteries or amplifiers, were exhibited. In the pocket foot-candle meter shown in Fig. 10, which is calibrated directly in foot-candles or lumens, the photo cell is fixed in the hinged lid and connections between the instrument and cell are made through the specially constructed hinge.

Another exhibit was a reflection meter, which is used for measuring the reflection properties of different surfaces. It incorporates a small electric light in the centre of an annular photo cell, and when the complete unit is placed against the surface to be tested the reading given indicates the relative reflection compared with that of a standard white surface. A new type of remote indicating tachometer—Fig. 11—consists of a small A.C. generator with an adjustable air gap and connected to a full wave rectifier within the housing. Leads from the generator are connected to a D.C. instrument of the required size and shape and calibrated in terms of r.p.m. The tachometer is suitable for indicating the speed of all kinds of rotating machinery and particularly when it is necessary to place the instrument some distance from the generator. Several instruments can be operated from a single generator, either together or separately.

One of the exhibits of the Marconi Company was the ultra-high-frequency Magnetron oscillation generator shown in Fig. 12, designed for studying the effect of concentrated high-frequency fields on bacteria cultures and pathological specimens. The high-frequency valve is a split anode magnetron, consisting of a straight tungsten filament surrounded by two half-cylindrical anodes in a hard glass, highly evacuated envelope. When a valve of this kind is placed in a strong magnetic field, so that the lines of force are co-axial with the filament-anode space, it is found that if an oscillatory circuit is connected across the two anode segments and the anode voltage is fed into the centre of the circuit oscillations are obtained, having a frequency dependent upon the natural frequency of the circuit connected to the valve. There is a critical value of the magnetic field at which oscillations can be obtained and as the field distribution must correctly be oriented within the valve, it is necessary to provide some means of rotating the valves through a few degrees in order to obtain the most efficient position of working. The high-frequency circuit consists, in the case of the apparatus exhibited, of a small variable condenser, across which a series of inductances can be connected in order to cover the necessary frequency range. Two conducting plates are arranged to enclose the subject specimens and the position of the plates can be varied to accommodate the different shapes of specimen boxes that may be used.

As it may not always be desirable for the specimen circuit to be at high potential, a coupled circuit rack consisting of two parallel adjustable strips mounted upon insulating supports has been provided. A sliding bridge connecting the two strips together enables the circuit to be tuned to the frequency of the transmitter, and as there is no high-voltage on these electrodes, specimens can be placed in position without interrupting the current.

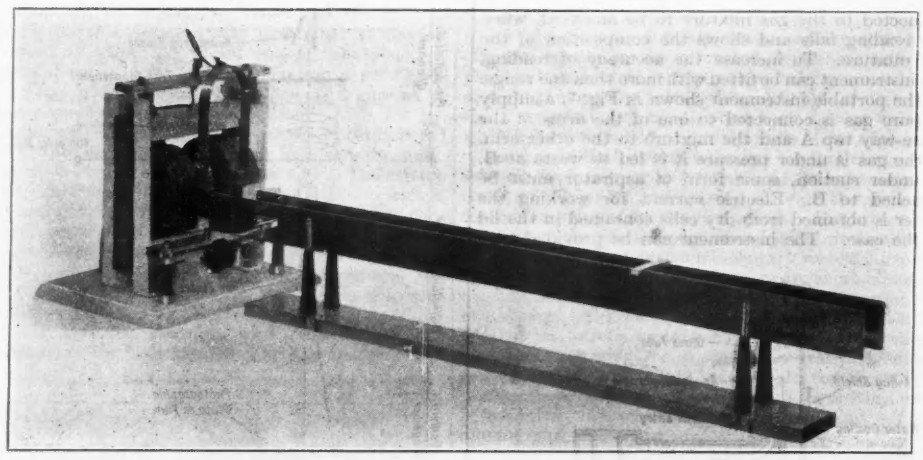


FIG. 12—ULTRA-HIGH-FREQUENCY OSCILLATION GENERATOR

(To be continued.)

Diesel Engine Users Association.

AT the recent annual general meeting of the Diesel Engine Users Association the first part of the proceedings was devoted to the election of officers for the following year. Mr. C. F. Mounsdon, M.I.E.E., was again elected President, and two members of the Committee to fill the vacancies were Mr. C. O. Milton, A.M.I.E.E., and Mr. J. L. Chaloner.

An informal discussion then took place on "Repairs to Diesel Engine Parts by Welding." The Hon. Secretary, Engineer Admiral Hope Harrison, stated that the object of the discussion was to gather evidence to show whether welding of Diesel engine parts was desirable, in order that inquiries from members might be answered as to whether the welding of fractured parts could be recommended. A number of members of the Association took part in the discussion, and many cases were quoted of cylinder heads being welded, after which they had given good service, for periods varying from four to six years. It was pointed out that repairs by welding might be considered in two classes, in the first of which welding was used in order to keep an engine running at a time when it was urgently required, when a spare part could not be quickly obtained, not with a view to a permanent repair, and, in the second place, when welding is resorted to in cases where the cost of welding is a fraction of the cost of a replaced part, and where there is every possibility of the welded part giving as good service as a replace part. It was stated that welding could be successfully carried out with cast iron and mild steel. A case was quoted in which an exhaust valve lever, for which no spare was available, had been successfully repaired within a few hours, and enabled an engine to run on a peak load, thereby saving nearly a thousand pounds for electrical purposes.

It was considered that the welding of parts in isolated stations abroad could not be recommended, partly on account of the difficulty and uncertainty of obtaining skilled welders, and of the fact that work of this nature would only have to be performed at long and irregular intervals. It was stated that, although crank shafts had been extensively welded in America, the general opinion in this country was that fractured crank shafts were not parts of an oil engine that most engineers would care to run if they had been welded, particularly crank shafts of heavy slow-speed engines. Cases were quoted of cracked piston heads that had been successfully welded and reinforced by mild steel plates.

Attention was drawn to the fact that expert welding firms at present were inclined to charge for repairs, not on the time expended and the work done, but on what it would cost a user to purchase a replaced part, and it was suggested that if expert welding firms would, as far as possible, arrange their charges to cover the work done and a reasonable profit, their businesses might be considerably extended.

Various processes of welding were referred to, one of which was a process of welding without heating the parts unduly.

It was pointed out that welding firms could nowadays give an opinion on a fractured part very quickly as to whether a satisfactory weld could be made or not. The opinion was expressed that the electric welding process was preferable to the oxy-acetylene process.

In conclusion, the President stated that users have a nervousness, and hesitate to use welding, and it is very desirable that this Association should collect as much information on welded parts, showing their behaviour on service after welding, and giving the difference in cost between welded and replaced parts. He stated that, although it was generally accepted that welding to be perfectly satisfactory should be carried out by expert firms who had sufficient work to keep welders continuously employed, he had had quite satisfactory welding of small parts done by a local garage by means of the oxy-acetylene process. It was generally considered that overseas members who control plants in out-of-the-way parts of the world should not be recommended to send defective parts long distances to be welded, but that a better course would be to order new replaced parts from the maker. That for two reasons, one that the time the engine would be out of action was practically the same in both cases, and where the cost of the replaced part was considerably more than the welded part, the risk of the weld not being satisfactory was cut out. A case was quoted in which a piston was sent some 14,000 miles to be welded, but only lasted a very short time after it was put into use. It was suggested that no firm of welders should be recommended by the Association who could not give a guarantee that it was in a position to check its work after it was done.

SIXTY YEARS AGO.

IN our issue of January 9th, 1874, we published the first of two articles on the forthcoming transit of Venus. We search in vain for an explanation of why an engineering journal should deal with such a purely astronomical subject. Reading between the lines, however, the truth seems to emerge. As a scientific journal we felt compelled to come to the aid of science against the attacks of those who praised and encouraged it only so long as it was directed towards the attainment of immediately useful ends. The articles, indeed, may be regarded as a rebuke to the utilitarianism of the mid-Victorian period. As a class engineers had done more than any other to promote that attitude towards life. Doubtlessly we felt it to be our duty to publish the articles and thereby emphasise the fact that engineers were not invariably the hard materialists that the world in general thought them to be. The forthcoming transit of Venus certainly provided an adequate occasion for a dispute between the utilitarians and those who believed in the extension of all scientific knowledge for its own sake and apart from any immediate practical gain which it might bring. There were many people, and in this country no less an organ than *The Times* lent them its support, who vehemently protested against the expenditure of public funds on expeditions to Kerguelen Land and Northern India to observe the transit. On the other hand, astronomers in Great Britain, France, Germany, Russia, and America had been looking forward to the event for nearly fifty years and with official assistance had for long been making their preparations to view the phenomenon forecast for December 8th, 1874. To-day the general public, educated in these subjects by Sir James Jeans, would, we believe, heavily support the astronomers. There was at stake nothing less than an opportunity of acquiring accurate knowledge concerning the scale on which the Universe is built. The ratios of the distances of the planets from the sun were, and had been for some time, known with considerable exactitude, but their actual distances as measured in miles were open to quite large probable errors. It was suspected, for example, that the accepted distance of the earth from the sun, namely, 95½ million miles, was incorrect by perhaps as much as 4½ million miles. Venus and Mercury are the only planets lying between us and the sun. Only once in about 112 years does Venus appear to pass across the sun's face. When it does so, observations, made from two stations on the earth's surface, of the apparent distance between its paths across the sun's face enable its and the earth's distance from the sun to be calculated in terms of miles with an accuracy far greater than that yielded by other methods. It may be added, perhaps, that in certain circumstances one transit of Venus can be followed by another at an interval of about eight years. There were, for example, transits in 1761 and 1769, and the next transit, that of 1874, was followed by one in 1882. There will not be another until 1986. Of the transits of 1874 and 1882 it is on record that no astronomical event was ever observed on a greater scale or at so great an expenditure of money. The results recorded were, however, discordant and in a considerable measure disappointing.

The Ashington Coal Cleaning Plant.

THE Ashington Coal Company, of Newcastle-on-Tyne, has an output of about 3,000,000 tons of coal a year from four pits—at Ashington itself, Woodhorn, Linton, and Ellington—while there is a fifth colliery in course of development at Lynemouth. All these pits are reasonably near together, on the north side of the Tyne, and offer the opportunity of supplying both steam-raising and household coal of a good quality. But it has been appreciated by the management that the "run of the mine," which was readily saleable a decade or so ago, is not of such a quality nowadays as to secure a ready market. The company has consequently installed and put into operation a central plant, of which we give illustrations on pages 40 and 44, devised to produce coal in the most marketable condition.

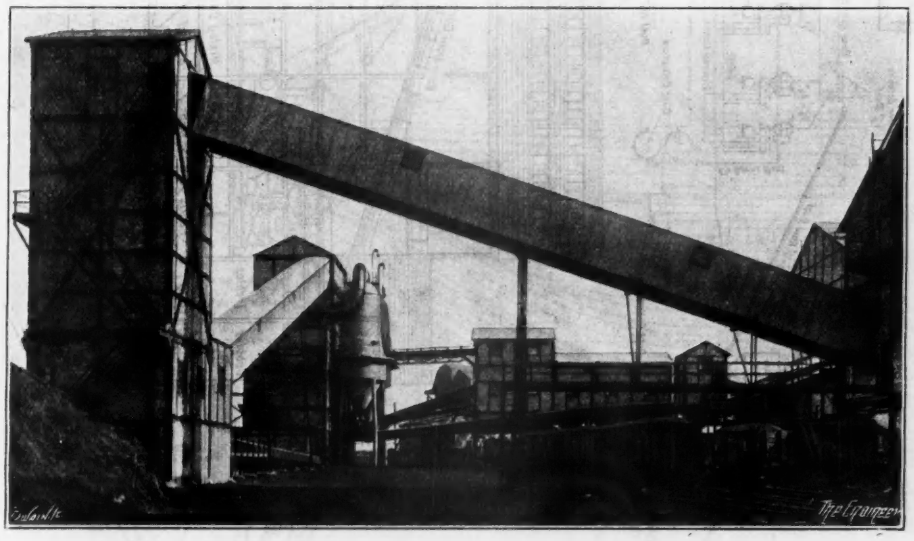


FIG. 1—AIR CLEANING AND GRADING PLANT

THE THREE PITS.

It should be pointed out that at the Ashington colliery there are three shafts, the Bothal and the Carl and the Duke, which raise a combination of steam and house coal to the extent of some 5500 tons a day. The coal from the other collieries is brought into Ashington for treatment by railway wagons. As a consequence the plant at Ashington has to deal with both the coal brought from the three local shafts, directly in the pit tubs, and also that trucked in from the other collieries. The coals of the several origins are handled quite distinctly, but they can, if it is desired, easily be mingled.

The plant which has been put up at Ashington for this purpose is indicated in our plan view, Fig. 3, which shows the relation of the pit shafts, the coal cleaning plant, and the railway sidings.

The majority of the tubs used at the Ashington pits have a capacity of 8½ cwt. of coal, but there are some of double the normal length which hold 21 cwt. In all, some 13,000 of these tubs are handled by the plant in a working day of 15 hours.

The tubs from the three pits gravitate on independent roads to their respective creepers, marked A on Fig. 3, and illustrated by the half-tone engraving, Fig. 2. These creepers raise the tubs to such a height that they can then gravitate through the rest of the operations. Each of the creepers comprises two strands of mild steel chain, with cast steel rollers between them on hollow steel spindles fitted with Enots nipples for grease gun lubrication. The carrying horns are spaced at 8ft. centres with intermediate rollers at every 4ft.

The tubs pass from the creepers to the three weighing machines B, see Fig. 3, and after weighing those from the Duke and Bothal pits, gravitate to the reception sidings—see Fig. 9, page 44—while those from the Carl pit are lowered by retarders C. In order to facilitate the arrangement of the roads for the separate weighing of each tub, and to avoid level crossings, the Carl creeper is extended above the Bothal and Duke creepers at the head. From the sidings the tubs are dispatched to the tipplers D from a central control station. This station, the front of which can be seen in Fig. 6, page 44, is equipped with pneumatic apparatus for controlling the points of the siding and the track brakes on the approach to the tipplers. The empty tubs, on leaving the tipplers, gravitate to the foot of the creepers E—see Fig. 3—two of which can just be seen on the extreme right of Fig. 2. These creepers raise the tubs again to a sufficient height for them to gravitate to their respective pits.

The coal from Ellington, Linton, and Woodhorn collieries is brought in by wagon to the track hoppers L L, where it can be unloaded into one of the three hoppers for delivering respectively into either of the dry cleaning plants or into the washing plant, whichever may be appropriate to the physical condition of the material. The third hopper is provided with a crusher to reduce the large coal when necessary, and also the intergrown coal as required, preparatory to washing. The band conveyors W take the coal from these hoppers, throw-off carriages being provided to enable it to be fed to the appropriate cleaning plant.

We thus have the advent of the several classes of coal, but before going on to their treatment we will dismiss the pit tubs.

Some of the empty tubs are required for handling stone, and these are diverted as required, and filled at the stone hopper P. (This hopper is supplied with stone as will be described later.) The stone-filled tubs are then raised by the creeper F and run forward along the gantries to the stone heap.

There is a sloping gantry joining the main gantry near the screen house, shown in the upper part of Fig. 3, which is provided with a creeper G and controller H as a means of communication between the surface level and the tub circuit. There is also a creeper J to bring the empty stone tubs back into circuit.

CREEPERS AND TIPPLERS.

In order to take full advantage of the reception sidings, the retarders are of special design to enable them to continue working and at the same time allow the tubs to stand on the incline. As soon as the track brakes at the bottom of the retarders are released, to allow the tubs to run to the tipplers, the tubs are immediately under the control of the retarders. Each creeper and retarder is driven by an independent motor, through cast steel machine-cut spur reduction gears. All shafts are fitted with Skefko self-aligning ball bearings in dustproof housings.

The main creepers A, on each of which it is possible to accommodate fifteen tubs, have automatic brake gear on the head shaft, which is interlocked with the starting clutch, so that in the event of stoppage of the creepers when full, the chains are prevented from running back. As an additional precaution safety catches are fitted, which come into operation on the body of the tubs and prevent them running backwards.

The tipplers are of the side revolving type, and arranged to take either one long tub or two short ones. One special feature of the design is the provision of doors which are directly over the tubs, and only open when the tippler has turned through about 150 deg. By this means the coal is kept under control and only allowed to slide gently out of the tubs. In order to facilitate the handling of large numbers of tubs, the whole of the tippler operation is under automatic or manual control at will. When under automatic control it is only necessary to keep a supply of full tubs in front of any tippler for that tippler to deal with them continuously.

In order to effect this, the tipplers are loaded by pneumatic rams, and the full tubs locked in position by the outgoing empty tubs. The rams, on their return stroke, set the tippler in motion. which, when it has completed its revolution, unlocks the empty tubs and operates the controls, both of the rams and the chocks holding the full tubs in front of the tippler, and the cycle begins over again.

SCREENS AND CONVEYORS.

Each jigging screen is set at a small angle and is capable of accurately sizing ten tubs of coal per minute. The screen is built in two sections and balanced, each section being carried by a series of ash hangers and driven by excentric sheaves and straps.

The picking belts are 51ft. centres by 4ft. 6in. wide, and are fitted with two strands of short pitched chain and mild steel joggled plates carried on cast iron rollers keyed to spindles running in self-aligning ball bearings, fitted with nipples for grease gun lubrication. The belts are driven at the delivery end, and each one is fitted with a Ferodo-lined friction clutch and remote control. The belts are totally enclosed, and provided with steam pipes between the top and bottom strands of plates for heating purposes, in order to secure greater comfort, and, consequently, greater efficiency, for the men engaged in cleaning the coal.

Pulsating loaders are fitted at the end of each picking belt, and consist of two sections interlinked. The first part is fitted with a screen plate to take out any small coal which may be made during the process of cleaning. The second part consists of a plain steel trough pivoted and fitted with gear to lower it into the wagons. The coal is consequently delivered into the bottom of the wagon without any drop. The motion of the trough is produced by special gear, so that the stroke or traverse varies inversely with the angle of slope, thus keeping the travelling speed of the coal constant whatever the position of the trough may be in the wagon.

The conveyors for dealing with the stone and intergrown coal are of the double-trough scraper type, arranged for conveying on both upper and lower troughs simultaneously in opposite directions. The inclined stone conveyor to the hopper and the inclined intergrown coal conveyor to the crusher are of similar design, but of the single-trough type. The remaining conveyors dealing with the coal are of the troughed band type, varying in width from 18in. to 30in.

The main inclined conveyors to the various cleaning plants are fitted with automatic cam gear, which prevents them from running back if the power is cut off while they are loaded.

The refuse conveyor from the Birtley air-cleaning plant is of the troughed band type, 18in. wide by 195ft. centres, and delivers into a scraper conveyor 24in. by 250ft. long, which acts as common refuse conveyor for the spirals and the washing plant.

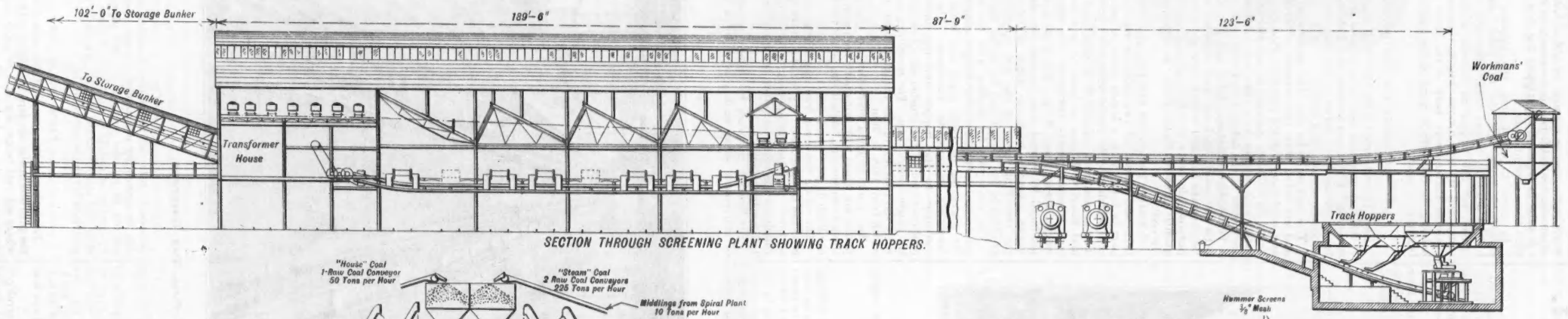
For driving purposes the plant is arranged in units of convenient sizes, each driven by a separate motor. Adjacent units can be coupled together so that two units can be driven by one motor in case of emergency. The motors in all the sections of the plant are controlled by contactor panels in dust-proof houses. By this means stop and start buttons can be placed in most convenient positions for the separate units.

FIG. 2—FULL TUB CREEPERS

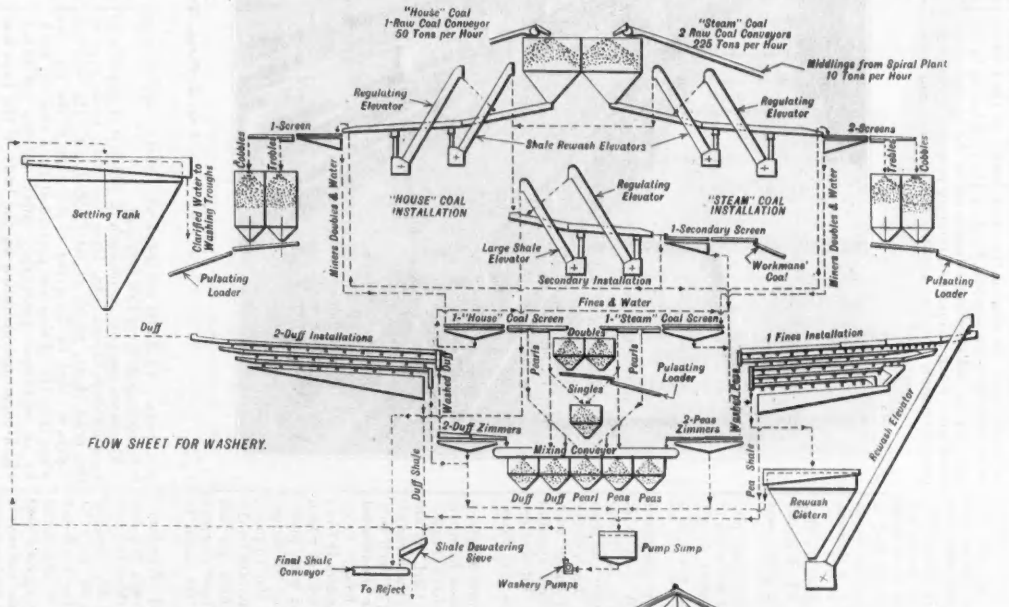
FLOW OF THE COAL.

Reverting to the course of the coal. That tipped from the pit tubs in the tipplers D falls on to the jigging screens, where all coal below 4in. size is taken out. The oversize passes on to the steel-plate picking belts, where stone and intergrown coal are picked off by hand. The clean coal is delivered on to the pulsating loaders N, which are fitted with perforated plates M to remove any undersize for

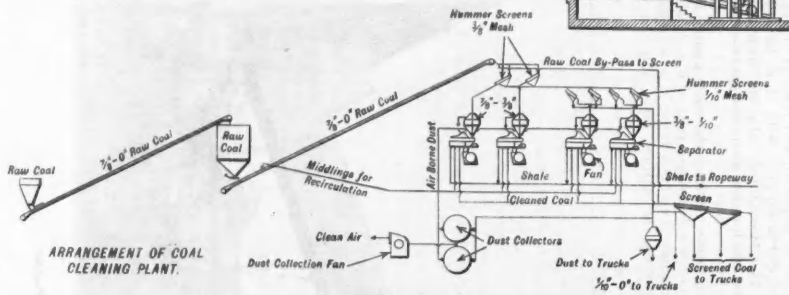
SCREENING PLANT AND WASHERY OF ASHINGTON COLLIERY COAL CLEANING PLANT



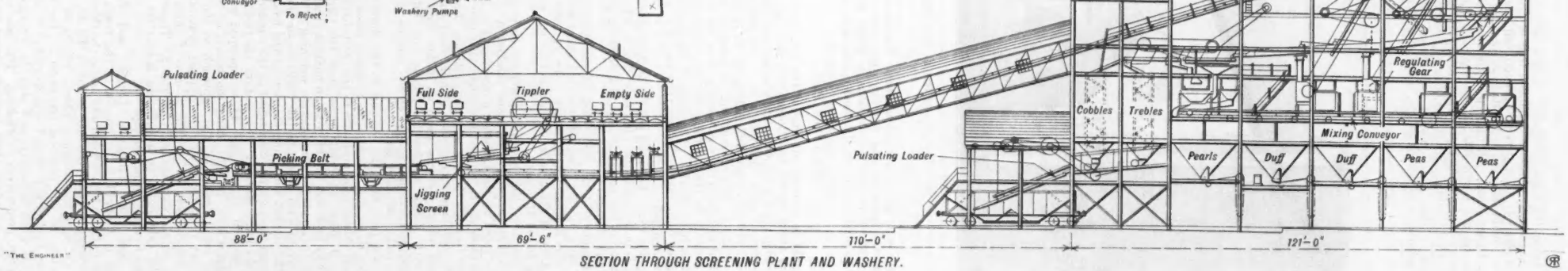
SECTION THROUGH SCREENING PLANT SHOWING TRACK HOPPERS.



FLOW SHEET FOR WASHERY.



ARRANGEMENT OF COAL CLEANING PLANT.



SECTION THROUGH SCREENING PLANT AND WASHERY.

"THE ENGINEER"

cleaning, and is delivered into railway wagons for dispatch.

The stone picked off the belts is placed on the bottom strand of the cross conveyors O, and then delivered by the conveyor P to the stone hopper, from which, as has already been explained, tubs are loaded periodically. The intergrown coal is placed on the top strand of the conveyors O and passes thence to the longitudinal conveyor C C into a 200 tons bunker D D, then by the conveyor E E to the Birtley air-cleaning plant F F)referred to later).

This dry-cleaning plant is, it will be seen, in two sections. One, for the coal from 4in. to 1in., which is cleaned on spiral separators. The other, for coal below 1in., is of the Birtley air-cleaning type. From them the coal goes

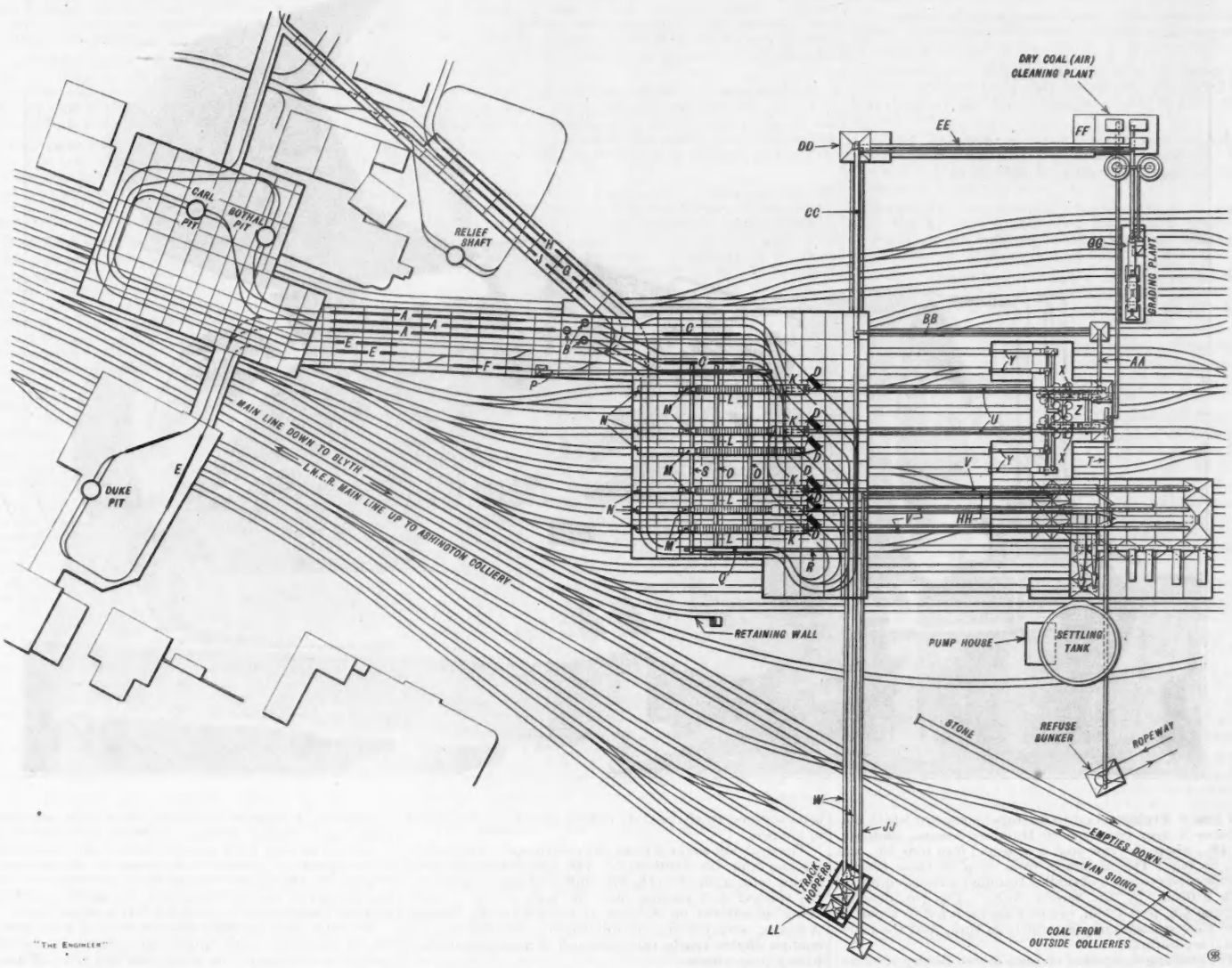


FIG. 3—PLAN VIEW OF COMPLETE COAL-CLEANING PLANT

veyor Q, which, in turn, delivers the coal into a crusher. After crushing, the coal, together with the undersize from the pulsating loaders, which is delivered by the cross conveyor S, is taken by the conveyors R, W and V to the washery, which is described later.

The coal below 4in. from each of the main screens K is delivered to five inclined band conveyors, two of these,

to a grading plant G G, making singles, pearls, peas, and duff.

The separator plant is arranged in two batteries, each consisting of eight spirals taking the coal from 4in. to 1in., which is graded on the screens into cobbles, trebles, and doubles. These are cleaned separately on the spirals and delivered by inspection belts on to their respective

and provide a steady supply for the screens, which are pitched at a small angle, and run at 160 r.p.m. to give accurate sizing.

The screens are made in two sections, balanced, and carried on ash hangers. They are driven by two pairs of excentrics set at 180 deg. on the main shaft, which is provided with fly-wheels and driving pulleys. The small

FIG. 4—PULSATING LOADERS

FIG. 5—REGULATING AND SHALE ELEVATORS

U, convey respectively the two house coals to the spiral separator cleaning plant Z, described later. The three conveyors V deliver the coal below 4in. to the Rheolaveur washing plant, which is arranged for washing separately the steam coal and the house coal as required.

In the spiral separator plant the coal below 1in. is extracted by screens X and delivered by means of the cross conveyor A A to a hopper, whence it can either be delivered into wagons direct as rough smalls, or can be loaded on to the conveyor B B, which delivers by way of the con-

pulsating loaders to wagons. The intermediates are elevated to join the raw coal conveyor to the Rheolaveur washery. The refuse from the spiral plant is delivered direct into the refuse conveyor T, which is common to all the cleaning plants. The refuse is conveyed to a bunker, and thence by an aerial ropeway (referred to later) to the heap.

The washing plant is arranged for making cobbles, trebles, doubles, singles, pearls, peas, and duff, together with a grade of workmen's coal, which is delivered by a

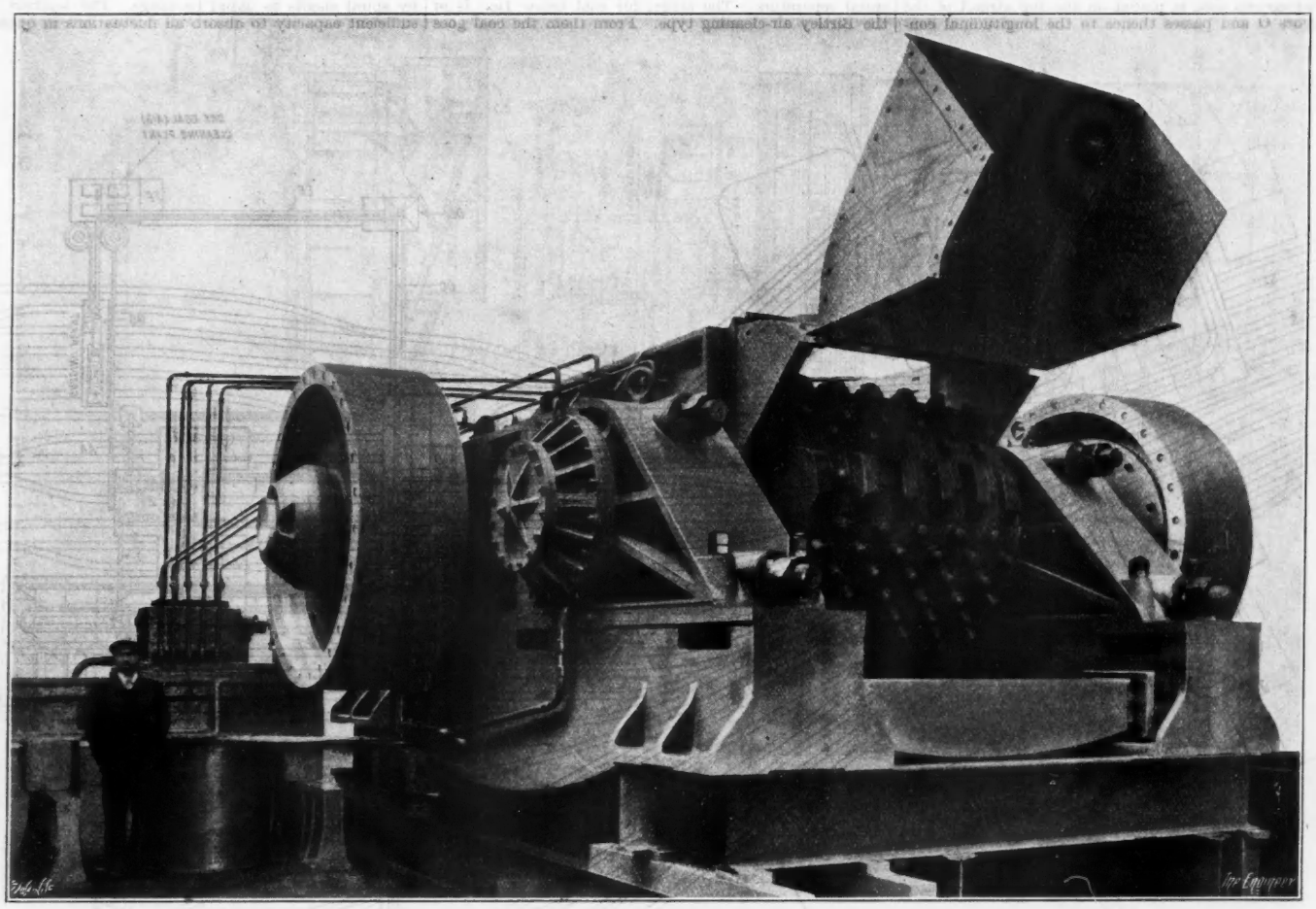
coal below 1in. is removed, the remainder, sized into doubles, trebles, and cobbles, is delivered to the spirals, which automatically remove stone and intermediates, delivering the clean coal to flat bands arranged as inspection conveyors. These bands deliver by the pulsating loaders Y to wagons in the same manner as in the main screening plant.

THE AIR CLEANING PLANT.

The air cleaning plant can deal with 140 tons per hour of raw coal, 1in. to 0in. At the head of the plant the

LARGE ORE CRUSHER FOR CORBY

HADFIELDS LTD., SHEFFIELD, ENGINEERS



raw coal is discharged on to a scraper conveyor which distributes it over two type 60 Hummer screens, each 8ft. by 4ft., where the raw coal is screened into plus ⅜in. and ⅜in. to 0in. The undersize from each of these screens discharges on to a pair of similar Hummer screens, equipped with 0·095in. by 3in. screen cloths. The ⅜in. oversize and the ⅜in. to 0·095in. product are each fed to a pair of mild steel storage hoppers, which, in turn, feed the pneumatic separators.

The cleaning equipment consists of two Birtley standard "Vee" separators, treating 1in. to ⅜in., and two similar machines treating ⅜in. to 0·095in. Each separator turns out two final products, and approximately 10 per cent. of the feed is recirculated as middlings.

The clean coal is taken by means of a belt conveyor to a grading plant, where it is normally sized into singles, pearls, and peas. Facilities are also provided for mixing any of these sizes, and adding the undersize from the Hummer screens if desired. Middlings are recirculated by means of shoots to a belt conveyor, which discharges on to the incoming raw coal conveyor. The refuse is fed on to a belt conveyor, which delivers on to the main conveyor T. The undersize from the 0·095in. screens can be delivered direct to wagons by means of a belt conveyor, either separately or with the filter dust, or, alternatively, it can be added to the clean coal as previously mentioned.

The four separators are enclosed in mild steel hoods which are connected by means of air ducts to two Birtley Waring filters. The filters, the bodies of which are of reinforced concrete, are connected up to a fan, and both filters are equipped with reversing valves for cleaning purposes.

All the motors are arranged for contactor starting and the whole system is interlocked so that should any unit stop all previous motors in the sequence will shut down simultaneously.

THE WASHING PLANT.

The Rheolaveur washery was designed to treat 225 tons per hour of 0in.–4in. steam coal, 50 tons per hour of 0in.–4in. house coal, and 10 tons per hour of intermediates from the spiral plant. Provision has also been made so that, if required at a future date, a further installation for treating 125 tons per hour of 0in.–⅜in. coal can be installed with very little modification.

From the raw coal hoppers the material is delivered to the respective main washing installations, each fitted with sealed type Rheo-boxes. In conjunction with these two installations, there is one common re-wash trough for treating the shale and middlings evacuated by the first Rheo-boxes in each trough. The clean coal passing over the ends of the respective troughs is delivered to main sizing screens, the cobbles and trebles being screened out and de-watered, and delivered by means of spiral chutes to the respective bunkers, while the undersize is delivered to secondary screens.

On these secondary screens the doubles, singles, and pearls from both washing installations are kept apart and stored in their respective hoppers, while the undersize, together with the water extracted by both screens, is delivered to the re-wash cistern. From this cistern the material is elevated to the double fine coal washing installation fitted with open discharge type Rheo-boxes. The clean coal passing over the ends of the first two troughs is de-watered on the peas de-watering Zimmers and stored in hoppers.

The drainage water is raised by centrifugal pumps to the settling tanks for clarification. The fine coal precipitating in this tank is piped to the two duff washing installations, the washed duff passing over the ends of the troughs being de-watered on Zimmer type de-watering screens. A mixing conveyor runs the full length of the building, and enables singles, pearls, peas, and duff to be mixed together in any proportions.

The flow sheet on the drawing of the washing and screening plant—page 40—fully illustrates the course of the coal through the washery, and it will be appreciated that the sizes of the grades mentioned can be varied within wide limits.

Although this plant was designed for a total capacity of 285 tons per hour, it has, under a prolonged acceptance test, treated 416 tons per hour without in any way affecting the washing efficiency; and the final washed product, together with the final shale, was well within the guaranteed figures.

THE AERIAL ROPEWAY.

The ropeway for disposal of all the refuse from the three cleaning plants has a capacity of 60 tons per hour, and is of bi-cable type, 2464ft. long, the carrying ropes being of lock coil construction, 1⅛in. diameter, and the haulage rope of flattened strand Langs lay construction, ⅞in. diameter. The buckets have a capacity of 15 cwt. each, and are fitted with a gravity type of hauling rope grip. They run on two wheels and are automatically tipped by a movable tipping gear. A self-righting gear at the loading terminal rights the buckets before they come under the loading spout ready for filling. The standards on the sections arranged for tipping are 100ft. high, and the maximum rope span is 710ft.

The general lay-out and the designs for the whole of the reconstruction scheme were carried through by the engineering staff of the Ashington Coal Company, Ltd., in conjunction with Goodall, Clayton and Co., Ltd., of Leeds, and the order for the manufacture and erection of the whole of the screening and grading plants, gantries, buildings, &c., was placed with that firm. The washery was also manufactured and erected by Goodall, Clayton and Co., to the design of the Rheolaveur Company. The air cleaning plant was manufactured and erected by the Birtley Company, Ltd., the auxiliary machinery and special grading plant being by Goodall, Clayton and Co. The aerial ropeway was manufactured and erected by R. White and Sons, Ltd., of Widnes.

A Large Ore Crusher.

SOME idea of the progress which is being made in the equipment of the new steel works of Stewarts and Lloyds at Corby, Northampton, to which we have referred before, may be gathered from the fact that the main ore crusher for the plant has already been completed, by Hadfields, Ltd., of Sheffield. This crusher, which is the largest that has ever been made in this country, is illustrated by the accompanying engraving.

The ore at Corby, where there are some 500 million tons in reserve, is difficult to handle, as it does not shatter easily and in some weather conditions becomes tacky; so, as will be seen, a roll type of crusher has been adopted. It is capable of dealing with masses of ore as large as 4ft. 6in. by 4ft. by 3ft., just as they come from the steam shovel, and in case of emergency can handle even larger lumps. The designed capacity is 500 tons per hour.

The rolls have studded shells of Hadura steel and are 6ft. in diameter by 5ft. wide. In addition to the usual conical studs, one of the rollers has two rows of heavier teeth, which have been named "slugger" teeth, to break up the larger pieces of ore so that they may be gripped by the conical teeth. The total weight of each roll is 30 tons and they are carried by shafts of Hecla forged steel. The shafts run in babbitted cast iron bearings with thrust collars to prevent end play, mounted in heavy cast iron housings, resting on two cast iron fish-back girders, or bedplates. These girders are connected together by massive cross pieces. The housings are grooved on their undersides to fit corresponding tongues machined on the bedplates, to which they are secured by bolts in T slots. Cast iron distance pieces are arranged between the housings and the distance apart of the rolls is determined by wooden packing pieces, while they are held together by long through bolts above and below the bearings.

The rolls are driven by separate motors at speeds of from 160 to 200 r.p.m., which is sufficient to throw off by centrifugal action any ore of a sticky nature that would otherwise clog the teeth. The driving pulleys are built up of wood, like those of a stamp battery, with cast steel side plates.

The side frames constituting the hopper are of cast iron and are lined with cheek plates of Era manganese steel to resist the wearing action of the ore. At each end of the machine there is a steel plate guard over the roll, one of which is shown lifted in our illustration.

Special attention has been devoted to the lubrication of the shaft bearings, and they are all completely flooded with oil when the machine is in motion. The oil is forced into the bearings by a specially designed oil pump driven by a small motor. This arrangement enables the oil pump to be started and an adequate supply of oil forced into the bearings before the crusher starts work. The pump has three suction and ten delivery plungers, and when the machine is in position will draw oil from a tank situated directly underneath it. The oil, after passing through the bearings, returns to the storage tank, which is fitted with an oil strainer for re-circulation. Each delivery plunger is fitted with a regulator by means of which the stroke can be varied from zero to maximum. Adjacent to the regulators the delivery pipes are furnished with indicators to show the rate at which the oil is flowing to each lubricating point.

The total weight of this crusher is 130 tons and it is noteworthy that there is sufficient kinetic energy stored up in the rolls, when they are running at full speed, and the power is shut off, to crush from 20 to 30 tons of ore before they come to rest.

THE next Show of the Royal Agricultural Society of England will be held at Ipswich from Tuesday, July 3rd, to Saturday, July 7th, 1934.

Railway and Road Matters.

WE are pleased to report that Sir Ralph Wedgwood, who has been seriously ill since June last, is now again at work.

SPEAKING in a discussion at the Institute of Transport on December 18th, Mr. G. Ellson, the chief engineer of the Southern Railway, said that that company had dispensed with over 200 signal-boxes, and there were now 1050 points and 1600 signals worked electrically.

ANSWERING a question addressed to him on December 21st, the Minister of Transport said that the tonnage conveyed to and from the Continent by train ferry was 130,692 tons in 1930, 75,300 tons in 1931, and 58,549 tons during the first eleven months of the present year.

THE traffic returns for the fifty-second week, and, therefore, the last of the year, record an increase of £87,000 for the year on the Great Western, of £3000 on the London and North-Eastern, and of £111,000 on the Southern. The London, Midland and Scottish shows a decrease of £310,000.

THE Road and Rail Traffic Act permits rates, less than those authorised by the Railway and Canal Traffic Acts, to be agreed between trades concerned and railway companies. Such have, however, first to be publicly advertised, and afterwards approved by the Railway Rates Tribunal. The first list of applicants for approval of agreed charges has now been issued and contains thirty-seven entries.

THE late Viscount Churchill, who died suddenly from pneumonia on January 3rd, succeeded the late Mr. Alfred Baldwin—Mr. Stanley Baldwin's father—as chairman of the Great Western Railway in 1908. His tenure of that office for twenty-five years was the longest of any chairman of that company. He was what in pre-grouping days was known as a "working chairman," *i.e.*, was to be found at headquarters on nearly every day.

WE regret to record the recent death of Mr. W. A. Lelean, who, being in charge of the locomotive department of Messrs. Rendel, Palmer and Tritton, had much to do with locomotive standardisation in India. Mr. Lelean was a premium apprentice of Mr. William Dean, of the Great Western. One of his activities during recent years was concerned with the progress of the Institution of Locomotive Engineers, of which he was President for 1932–33.

THE L.M.S. Railway Company has introduced a new type of container unit, known as type "X," which has been designed by Mr. W. A. Stanier, the company's chief mechanical engineer, for the conveyance of pedal cycles from manufacturers' works to distributors. It is built of timber, reinforced in the roof by steel angles, and in the sides, ends, and floor by pressed steel knees and plates. The cycles are loaded in two tiers. Each container carries seventy cycles.

THE Ministry of Transport railway statistics for September also gave the result for the third quarter of the year. They showed that, compared with the corresponding period of 1932, the number of passenger journeys increased by 2·1 per cent., and the receipts from passengers by 1·3 per cent. Passenger train mileage rose by 3·2 per cent. Except in minerals—which increased 3·3 per cent. in tonnage and 3·5 per cent. in receipts—there was a decrease of 1·0 per cent. in freight tonnage, and of 2·8 per cent. in freight receipts. Freight train mileage was reduced by 1·1 per cent.

ONE of the Liverpool Corporation tramcars got out of control and was derailed when descending a steep hill on January 3rd, whereby two passengers have lost their lives. At the coroner's inquest the representative of the City Council said that tramways were still the safest means of road passenger transport. The tramcar passenger public of Liverpool might rest assured that everything possible was done, and would continue to be done, to ensure their safety in tramcars. The policy of safety adopted was reflected in the very small number of se ious accidents which resulted from the operation of Liverpool tramcars. Although there were comparatively steep gradients and sharp curves on the Liverpool Corporation tramway system, there had never been any fatal accident before in the city in consequence of a tramcar being derailed.

IT is reported that on Thursday, December 28th, the "connecting-rod"—we presume the coupling-rod is referred to—fell off the engine of a passenger train whilst it was running through Morley tunnel on the L.M.S. between Huddersfield and Leeds, and that the passengers were detained there for three hours. This seems a long time, but the tunnel is almost 2 miles long, and some time would first be spent by the driver and guard agreeing what should be done and the guard would then proceed to the signal-box in the rear to obtain assistance. That assistance, in this case, could only come from the nearest engine depôt. That would take time, and afterwards there would be the actual repairs to the engine. These, we read, took two hours. An apparently easier course would have been to send an engine into the tunnel, under a "wrong-line" order form, and for the carriages to be drawn back out of the tunnel, but there might have been difficulties in the way of that step.

THE Minister of Transport has issued a notice as to the Road and Rail Act which came into force on January 1st, and what is thereby entailed. Incidentally, it is remarked that steps are being taken to set up the Transport Advisory Council. Mention of this subject permits us to observe that it is a good sign that Mr. E. C. Marston, President of the Road Haulage Association, said to a representative of *The Times* that its effect would be beneficial to those road transport undertakings which were well conducted and organised, but must be fatal to the irresponsible type, which had brought so much discredit in the past on that class of road transport. He thought that there seemed to be considerable hope of developing the policy of co-ordination between road and railways as the result of the Act if all forms of transport approached the matter in the right spirit. One of the most hopeful parts of the Act was that referring to the Transport Advisory Council to be set up by the Minister to consider the general policy of transport as a whole.

Notes and Memoranda.

IT is asserted by the *Hot Springs News Era* that fires cause the loss of about 10,000 lives and damages to the extent of 500,000,000 dollars annually in the United States.

IT is reported that during the recent wintry weather in Saxony telephone wires accumulated so much ice and snow that their weight was raised to 25 lb. a yard, while the weight on four wires carried by posts 60 yards apart was 4 tons.

LECTURING on the merits of wooden doors as fire barriers before the National Fire Brigades' Association, Mr. A. H. Barnes said that the door must be so secured when closed that the top and bottom of the locking style, as well as the middle, are held back tightly on the fillet of the door frame.

ACCORDING to some experiments carried out by Mr. R. H. Heald, of the United States Bureau of Standards, the elimination of "bumpers," spare tires, and headlights, combined with a sloping wind shield and a rounded top, will decrease the power demands of a motor car by 10 horse-power at a speed of 60 m.p.h., and by 20 H.P. at 70 m.p.h.

SOME idea of the extraordinary rapidity with which Empire production has developed may be gained, states the *Electrical Times*, from the fact that whereas in 1931 only 16 per cent. of the copper imported into this country was of Dominion origin, in 1932 this figure was increased to 34 per cent., and in 1933 to no less than 53 per cent., the figures being approximately correct for the first ten months of each year.

ACCORDING to Dr. H. C. Gunning, of the Canadian Dominion Geological Survey, there exists the possibility of securing a source of vanadium ore on Quadra Island, about 120 miles north of Vancouver. In the seam now being developed by Radium Explorers, Inc., ore samples tested 2·16 per cent. vanadium. Radioactive minerals have also been known on the island for some years, and analyses of material have shown carnotite of extreme richness.

CREEP characteristics at 1600 deg. Fah. of fifteen different alloys, covering a range of chemical composition from 1 to 75 per cent. nickel and from 3 to 55 per cent. chromium, were determined at the American Bureau of Standards by W. A. Tucker and S. E. Sinclair, and reported in research paper No. 572. The determinations supplement a previous investigation at 1000 deg. At 1600 deg. the strongest alloys are those containing approximately equal parts of nickel and chromium and not more than 30 to 40 per cent. iron.

WHAT are believed to be the fastest passenger elevators in the world have recently been put in operation at Rockefeller Centre, New York City, with twenty-four of the seventy-five Westinghouse elevators in the main building operating at 1200ft. per minute. During performance tests some of the cars were run at 1500ft. per minute, and one car has been tested and approved by city inspectors to operate at 1400ft. per minute. These elevators are of the automatic landing type, with a travel from 497ft. to 770ft. The highest rise cars make a round trip with terminal stops only in 95 sec. They will be in motion about 58 per cent. of the time, and for 40 per cent. of the time will be running at full speed.

BRICKS with a high content of corundum can be made in one or two ways. First, the refractories can be made direct from diaspore or bauxite, but such bricks often have the unfortunate tendency of "creeping" and showing after-contraction at 1500 deg. Cent. and over. Or, the bricks can be made with straight corundum. In this case the properties depend on the nature of the bond and on the firing temperature. Work in recent years has been directed towards the elimination of the bond and on the attainment of sufficiently high burning temperatures. However, corundum bricks have, according to John G. Stein and Co., Ltd., Bonnybridge, Scotland, definitely gone beyond the laboratory stage, and they find successful application in rotary cement kilns, boiler linings, and in furnace structures demanding high rigidity at temperatures over 1500 deg. Cent.

A NEW metallic lead thread lubricant, recently placed on the market by Armite Laboratories, of Los Angeles, is claimed to be of great value in the assembling of machinery and in the repair of equipment that is subjected to heavy duty, high temperatures, and general abuse. The product is described as being a very finely divided metallic lead in paste form, and in use it is said that a film of metallic lead is formed between the threads that prevents binding, speeds up repair work, and cuts costs. Stud bolts on heads and exhaust manifolds will not freeze, nor will pipe threads corrode together, regardless of time, as the lead does not oxidise or harden. The makers also claim that this lubricant used on liners and fly-wheels facilitates their insertion or removal, and say that even a bright red heat does not harden or destroy the compound in the threads, making it an ideal dope for exhaust studs.

ACCORDING to investigations of O. Hengstenberg and F. Naumann, described in Report No. 219 of the Materials Sub-committee of the German Ironmasters' Association, which is published in the *Archiv für das Eisenhüttenwesen*, twofold treatment of various steels with ammonia, first at a low temperature and then at a high one, increases the depth of the nitrided surface without seriously affecting the maximum hardness, provided the temperature of second treatment is not so high that the nitrides become agglomerated to any extent. There is no advantage in using a lower temperature for second nitriding than for the first. These results were confirmed by measurements made on sloping sections cut through a nitrided layer which was given second treatment at a higher, the same, and a lower temperature than that of primary nitriding. In no case was the maximum hardness, obtained by sufficiently long primary nitriding, exceeded on further treatment, but the hardness within the nitrided layer increased in inverse proportion to the nitrogen content acquired during primary treatment. The diffusion velocity in these layers also determines the increase of depth on second nitriding, that in the outer zones having little influence on this factor.

Miscellanea.

AN aerodrome is being laid out at Aberdeen.

THE new Perth flying boats, which are to replace the Southamptons at Mount Batten, near Plymouth, weigh 15 tons and carry a crew of nine.

THE construction of a naval port on the coast of Hainan Island to strengthen the coastal defence of Kwangtung is being contemplated by the Chinese military authorities.

THE amount of shipping laid up in South Wales ports has been reduced from sixty-one vessels, of 115,685 tons, a year ago to thirty-four vessels, of 59,419 tons, at the present time.

A NEW bore-hole providing 100,000 kilos. of volcanic steam an hour has been put down at Larderello, Italy. The steam is to be used for power purposes and for the recovery of boracic acid.

GLASSHOUSES for growing tomatoes are to be erected near the Partington gasworks, Manchester, which will supply waste hot water for heating purposes. This supply will amount to 12,000 gallons an hour.

IT is proposed to construct a dam across the South Saskatchewan River at Riverhurst, near Moose Jaw, Canada, with the object of developing 100,000 horse-power, and irrigating a million acres of land.

IT is proposed by the Low Temperature Carbonisation Company to put up two more plants capable of treating 300,000 tons of coal a year. One will probably be in the Forest of Dean and the other in Lancashire.

AT the ordinary meeting of the Institution of Electrical Engineers, to be held at 6 p.m. on Thursday, January 18th, 1934, Viscount Falmouth will present to the Institution a copy of Sir William Orpen's painting of Sir Charles Parsons.

UNDER an 87,000,000 dollars money by-law recently passed by the ratepayers of Detroit, Mich., it is proposed to construct a double track subway nearly 20 miles in length for the purpose of carrying vehicular traffic throughout the city area.

THE Corporation of Hull is taking over the local aerodrome of National Flying Services, Ltd., and proposes to make an arrangement with the Royal Dutch Air Lines for a regular service between Hull and Amsterdam. A service is also to be arranged between Derby and Hull.

THE Australian Government has decided to put up four new wireless stations at Launceston (Tasmania), Townsville (Queensland), Sale (Victoria), and Grafton (New South Wales). The plants will be of 7 kW each and will be supplied by the Standard Telephones and Cables Company.

MORE attention should be paid to the historical side of discovery, said Major Freeth in a recent address. Students should remember that if they wish to avoid the mechanisation of their own minds, they would be well advised to read the history of the particular subject in which they were interested.

THE photographic library of the Topographical and Air Survey Bureau of the Canadian Dominion Department of the Interior at Ottawa has now collected more than 500,000 aerial photographs, which are filed and indexed for consultation by business men seeking information for use in engineering and other development work.

A FERRY boat which has just been put in service between Hongkong and Kowloon, and which was built by the South China Motor Shipbuilding and Repairing Works, has as propelling machinery an eight-cylinder Crossley-Premier horizontal oil engine of 540 H.P., connected with the propeller through a B.T.H. generator and two motors of 420 H.P. to the twin propeller shafts.

PROFESSOR H. BRIGGS, Hood Professor of Mining, Edinburgh University, and Professor of Mining in Heriot-Watt College, has agreed to act as Chairman of the Technical Committee which the Scottish National Development Council has decided to appoint to inquire into the whole question of the production of oil, &c., from coal and shale in Scotland. It is expected that an early announcement will be made regarding the complete *personnel* of the Committee.

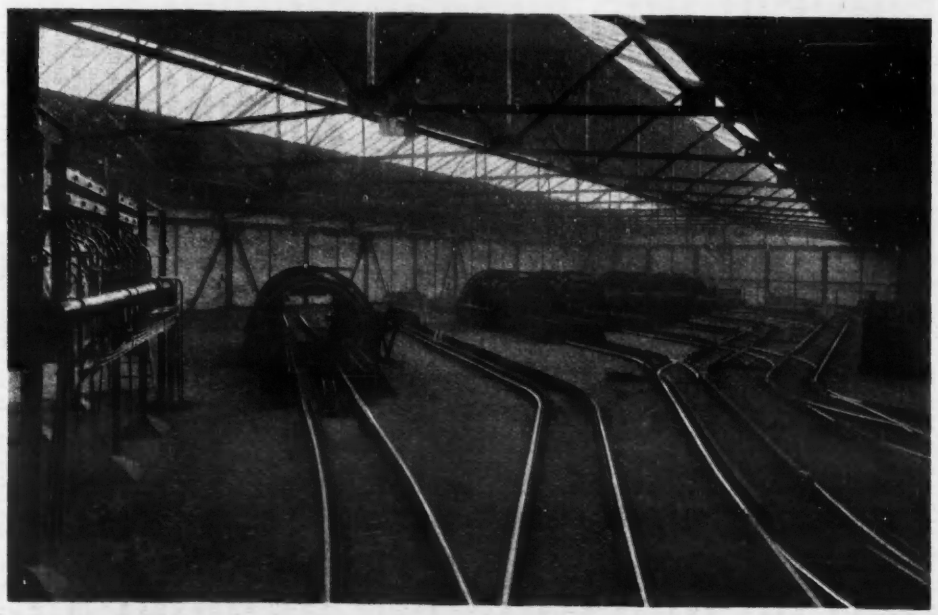
IN the course of a lecture before the Junior Institution of Engineers, Mr. G. V. Rickards said that before the war nearly 80 per cent. of the drawing-office materials used in this country were manufactured abroad, but an association of the leading makers in this country had resulted in a pooling of knowledge and experience with such resultant general improvement in the character and dependability of materials as well as many new developments that the ratio between British and foreign materials was now more than reversed.

IT appears from a statement made in the Legislative Assembly of India that there is a proposal under consideration that engineering officers, who pass out of the Indian Military Academy, should complete the post-graduate course at the Thomason College, Roorkee, followed by a period of training with the King George's Own Bengal Sappers and Miners at that station. The financial implications of the proposal are now being examined. The Government of India will also consider the nationalisation of the Roorkee Engineering College when examining the financial implication.

THE Society of Chemical Industry has organised a new Group, known as the Road and Building Materials Group. It has a very extensive scope, and embraces the subject in the widest possible sense. Its activities will cover the study of all materials, processes and methods either used or projected in the roads and building industries, and any other topic allied with or of interest to such studies. While realising the value of the work in part of this field carried out by such bodies as the Institution of Civil Engineers, the Institution of Structural Engineers, and others, and without intention to create any semblance of competition, the Group sets out to tackle the vast amount of untouched work based mainly on chemistry and physics which comes obviously within the Society's ambit. In short, the objects of the Group are generally to advance the science and technology of road and building materials.

COAL-CLEANING PLANT AT ASHINGTON COLLIERY

(For description see page 39.)



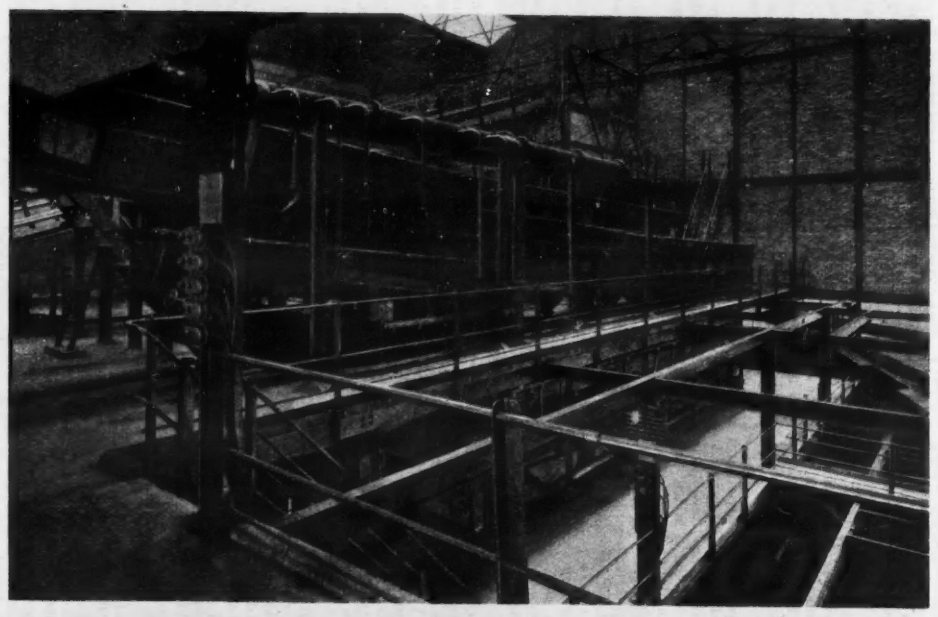


FIG. 6 (ABOVE):—TIPPLERS
FIG. 7 (BELOW):—FINES AND DUFF WASHING INSTALLATION

FIG. 8 (ABOVE):—INTERNAL VIEW OF WASHING INSTALLATION
FIG. 9 (BELOW):—RETARDERS AND RECEPTION SIDING

The Engineer

JANUARY 12, 1934.

VOL. CLVII. No. 4070

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STEEL PASSENGER ROLLING STOCK.

THE recent French railway disaster has revived an agitation, in some quarters, for all-steel passenger coaches. Figures have been given to show that there are very few such vehicles on British railways. In any argument on that point it must be determined what is meant by an all-steel coach; if it be agreed that it is one in which both the underframe and body are wholly of steel, it has to be conceded that there are comparatively few, except those used in electrically operated train services, on the lines in this country. An explanation for this apparent slow progress is to be found in two factors. One is that the agitation arose originally from the need for safeguarding wreckage in a collision against fire. There have been five serious accidents which were followed by disastrous fires, viz., Hawes Junction, on December 24th, 1910; Ais Gill, on September 2nd, 1913; Quintinshill, May 22nd, 1915; Jarrow, December 17th, 1915; and Charfield, October 13th, 1928. Such a record cannot but have impressed the builders of rolling stock and railway officers generally with the need for avoiding a repetition of such disasters. It fell to the late Mr. R. W. Reid, the carriage and wagon superintendent of the then Midland Railway, to have to deal with the subject of the means of preventing the outbreak of fire after an accident, when reporting on Rolling Stock to the Rome International Railway Congress of 1922. His remedy was to avoid collisions! That may sound like a counsel of perfection, but something very similar was said by Sir John Pringle in his report on the Charfield accident, when he remarked that if means were adopted for preventing accidents, caused by drivers failing to observe signals, expenditure in other directions would be less necessary.

Telescoping, as a result of collision, is the great evil to be avoided. That was manifest in the Hawes Junction accident, whilst the Ais Gill case showed what the Midland had done towards preventing telescoping in the intervening two and three-quarter years. The Dinwoodie accident, twelve days later than Charfield, was, however, splendid testimony to the efficacy of the steps taken after Hawes Junction. There the "Royal Highlander," drawn by two engines and consisting of ten eight-wheeled and two twelve-wheeled coaches, ran into a freight train at a speed of 60 m.p.h. The two engines of the express were derailed and the leading coach of the express mounted the *débris*. Colonel Mount, reporting on the accident, said that the effects of the collision on the coaching stock of the express as a whole was remarkably small. All the vehicles had steel underframes and all, except the last, were of modern heavy construction, and, with the same exception, fitted with Spencer's double-action shock-absorbing buffers. In concluding his report Colonel Mount observed that there was no doubt that the type of buffer referred to was severely tested and played an important part in preventing telescoping and in minimising effects upon passengers, and damage to the vehicles. For instance, the Colonel added, all doors of the third coach subsequently opened quite easily and not a window was broken in rear of the second coach, except one pane which was cracked in the fifth. Coming, after a lapse of nearly five years, to the Bowling Basin collision of September 8th last on the London and North-Eastern Railway, where a Helensburgh to Glasgow express, running at 50 m.p.h., collided with some wagons, we find Colonel Anderson reporting that the six bogie vehicles of the express were all of modern construction, with well-braced underframes and wooden bodies. Although the engine and all the coaches were derailed there was no overturning or telescoping. Considering the speed at which the collision occurred, the damage was small. It was confined mainly to the front of the engine and to the bogies and running gear of the coaches; there was only one broken window in the whole train. In concluding his report Colonel Anderson said that that collision was remarkable for the small number of injuries involved. That must, he thought, be attributed to the excellence of the design and construction of the modern rolling stock of which the express train was composed.

Three other points need briefly to be mentioned. The first is that the risk of fire from escaping gas after a collision or derailment is being greatly reduced by the more general use of electricity as an illuminant; the Railway Returns show that the proportion so lighted is now 65 per cent. of the whole. The second point is that since the reference to Charfield in 1928 telescoping has not once been mentioned in the annual reports on British railway accidents. Lastly, as illustrative of the other side of all-steel stock, it may be remarked that after the collision of January 28th last between an electrically operated passenger train and a goods train at Three Bridges, Southern Railway, the wreckage of the motor coach had to be cut apart with oxy-acetylene torches in order to release the motorman and the guard of the goods train. It must not be overlooked that the impact between an all-steel train and a "wooden" train, as in the recent deplorable French accident, is very different from one between two all-steel trains.

The Looker-On.

IT is astonishing how often we require someone else to point out to us the obvious. A little article, which we reprint by permission of the Institute of Industrial Psychology, provides a shining example. In an electrical instrument repair works the benches were untidy. A housemaid could have tidied them and an intelligent housewife would have devised the means of keeping them tidy. Yet to do the job, the Institute of Industrial Psychology was called in. It made quite neat arrangements, as our article with its illustrations shows. Probably many similar works and many amateur workshops will benefit from the hints. But if the Institute of Industrial Psychology could devise a few shelves and compartments, why could not someone in the works do so? Probably Mr. Hunt, who signs the article, designed the equipment. In what way was he particularly fitted to do something which those who were in daily touch with the needs ought to have known still better how to do?

There is more in this than meets the eye. It is not because the manager or even the sub-foreman of the works was incompetent to make sketches of a few shelves and racks; it is not, probably, because neither saw the advantage of so doing. That had been pointed out by some of the workmen, and that it must have been recognised is shown by the adoption of the Institute's proposals. There is something behind it all, and as likely as not psychology is as gentle a name for it as may be given. The minor prophets are without honour amongst their own people. The workmen who had averred that the benches could be tidied were only half believed. It required a greater than they, a detached entity with a high-sounding title, to bring conviction. The case is a simple one, but it might be multiplied a thousand times in every industrial country. The external adviser lives on this strange psychological weakness that works managers do not, perhaps we should say can not, see all their own affairs in proper perspective, and if shown them by a junior may persist in their blindness. Of course, there are cases in which genuine difference of opinion exists. The need of a change is recognised, but the means of effecting it are open to question. In such circumstances the external adviser may prove to be an invaluable arbitrator. It is not these excusable cases that we have in mind, but rather those in which it was the obvious duty of the manager to do the very thing which was done under the advice of a stranger. That is the matter that needs looking into. It may call for some heart-searching. The manager may find that he has been too short with suggestions placed before him by his juniors; again, the directors may find that they have turned a deaf ear to the recommendations of their manager; and both may have seen the need of a change, but have postponed it to a more convenient season. Manifestly if, after all, an outside adviser has to be brought in to say what ought to be done, and his advice is at once recognised as sound, the managers and directors ought to be handsomely ashamed of themselves. To the best of our belief they very rarely are. On many occasions we have heard them declare that they called in so-and-so and his advice was so effective that they had reduced time or material wasted by such-and-such a percentage. Surely that is all wrong. Surely in a well-managed works the staff ought to know better what is required and how to get it than any outsider spending no more than a few days gleaning information by observation. Is it possible that none of the works which benefit from the ministrations of the doctors are really well managed, or is there—as indeed we suspect from the evidence—some psychological effect which prevents those who are the nearest to the work seeing it in all its detail. If that is the case one might recommend that managers, like professors in American universities, should be given a sabbatical year—or a few months might do—to get right away from their own work so that when they came back they would see it with clearer vision. In the making of paper it is the business of certain men to match the tints. After a time their eyes get tired and they fail to see differences which are patent to others. That is not regarded as any disgrace, but merely as an indication that the eye needs a rest or change of occupation. In two or three weeks the acuteness of vision is restored. The works manager may get blind by always looking on the same thing; and the cure may be of the same order.

The suggestion-box figures in the internal economy of many works. Sharp differences of opinion concerning its value may be heard. Some works claim that really useful results have been attained and that practically valuable suggestions have been found in the box. Others regard the boxes as psychological safety valves; they give the workmen a ready means of putting their ideas before the board, and the board gives the men small gifts to encourage them, but never adopts their ideas. Its attitude is justifiable. Yet it may fall into the error of believing that because it employs experts to manage the works or design machines they will see everything. As a matter of fact they may be too busy to see something that is staring them in the face, and the suggestion-box may give them a hint that will open their eyes. It all depends upon how it is used, and particularly on the attitude towards suggestions coming from men in junior positions. Jealousy is inevitable. It is a human trait from which none wholly escape and to which men who believe that their position will be jeopardised by the encouragement of their inferiors are particularly liable. If managers knew that they would be credited with some share of the honour which fell to any of their subordinates that kind of jealousy might be displaced. And, after all, there is nothing illogical in that. The manager who is wise enough to encourage his staff to make suggestions and turns a ready ear to them has merits above him who endeavours to take all credit to himself and will consider no changes which he himself cannot, justly or unjustly, father.

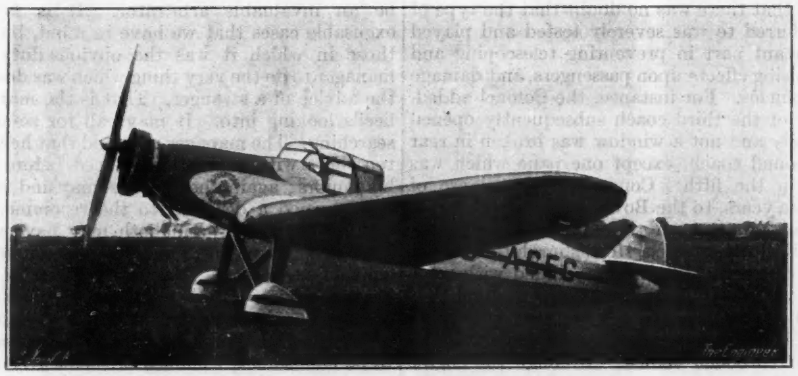
Aeronautics in 1933.

No. II.

(*Concluded from page 8, January 5th.*)

WE conclude our account of the activities of British aeronautical manufacturing companies during the past year.

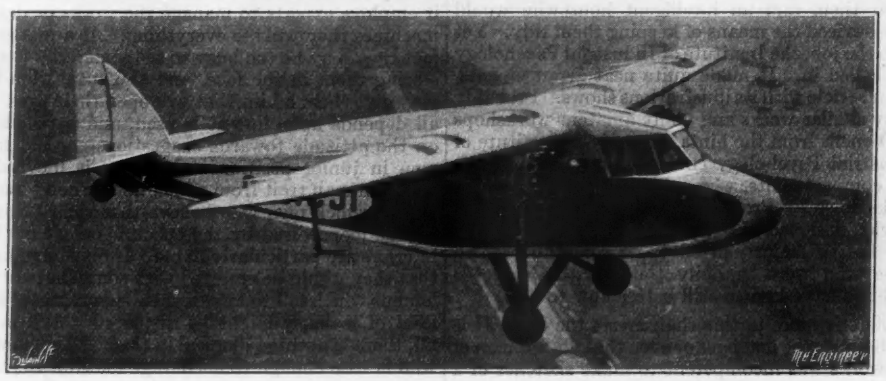
Spartan Aircraft, Ltd.—At the Cowes Works of Spartan Aircraft, Ltd., the two designs of machine known as the Mark II. three-seater, and the "Cruiser," and described and illustrated on previous occasions, continued to be produced. The Spartan "Cruiser" is a particularly interesting machine, both from the constructional point of view and the duties which it is designed to fulfil. It is a three-engined cabin monoplane, with the wings cantilevered out approximately in line with the cabin floor. The fuselage is of duralumin construction throughout, and is composed of light frames plated with "Alclad," and of bulkheads composed of the same material. The tail unit is a duralumin structure covered with doped fabric, but the wings are composed of a wooden framework covered with a three-ply skin, inspection holes covered with fabric patches being formed in the skin at convenient positions. The machine is primarily intended to operate on "feeder" services to air lines, and to that end has been designed with close attention to adaptability and to operation over country providing little or no opportunity for effecting a forced landing in safety. As regards its adaptability, it has to be noted that the cabin can be fitted with seats for ten passengers and the pilot, but in such a case the endurance of the flight would be limited to two hours, because of the reduced weight of fuel that could be carried. Various alternative arrangements are, however, possible. For example, with six passengers and a pilot and 30 lb. of luggage per passenger, sufficient fuel can be carried for a flight of 4¾ hours' duration. Safety against forced landings is ensured by providing the machine with a very liberal reserve of power. The three "Gipsy" Major engines are normally run at 150 r.p.m. below the engine builders' normal speed. If one of the engines fails the remaining two can be brought up to the engine makers' normal speed. In this condition the "Cruiser" can continue to fly, while by opening up the throttle still more it can even climb. In the event of a second engine failing, the continued operation of the remaining one will delay the descent to such an extent as in most cases to permit a safe landing ground to be reached. It is on record in this connection that, during a demonstration test, a "Cruiser" carrying a moderately heavy load covered, before landing, a distance of as much as 40 miles from a height of 6000ft. with only one engine in action.



SPARTAN "CLIPPER" LIGHT TWO-SEATER MONOPLANE

The company produced during the year a new design, the Spartan "Clipper," illustrated herewith, a small two-seater monoplane driven by a Pobjoy engine. Pressure of work on "Cruiser" machines prevented this new design being put into production during 1933. The fuselage of the "Clipper" is of plywood construction, while the wings are of the metal "Monospar" type made by the General Aircraft Company. In the enclosed cockpit two side-by-side seats are arranged, and dual control is provided. The machine has an empty weight of 770 lb., and with a crew of two, 15 gallons of fuel, 3 gallons of oil, and 50 lb. of luggage, weighs 1300 lb. Its top speed is 110 m.p.h.

Short Brothers, Ltd.—At Rochester a new twin-engined general-purpose boat seaplane was completed. This machine is a monoplane with a very novel wing arrangement. Two "Scylla" land planes were put in hand for Imperial Airways. These aircraft are in general similar to the "Scipio" flying boats now in service on the Mediterranean, with the hull and wing tip floats omitted, and a fuselage and land chassis added. Accommodation is provided for thirty-nine passengers and a crew of four. The machines will be driven by four "Jupiter" or "Pegasus" engines.



SHORT "SCION" TWIN-ENGINED PASSENGER MONOPLANE

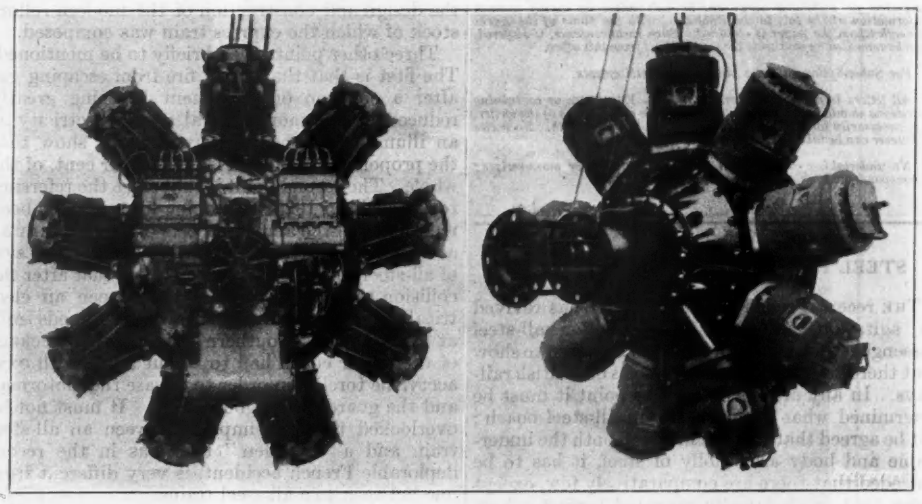
Another design of land plane produced by Messrs. Short during the year is illustrated herewith. This machine, the "Scion," is a twin-engined light civil passenger monoplane, designed for service on feeder lines to main aircraft routes, and for similar purposes. It is driven by two "Pobjoy" engines, the mounting of which is exceptional in so far as they are hinged on the rear spars of the wings in such a way that they may be swung clear of the planes to provide easy access to them. The pilot sits in an enclosed cockpit, having a sliding roof and opening windows, while behind him is a cabin comfortably holding five passengers. For the construction of the fuselage, welded high-tensile steel tubing covered with fabric is employed. The nose piece of light framework is hinged to the main part of the body to enable easy access to be obtained to the pilot's seat and the controls. At an all-up weight of 3000 lb., and with the engine running at 90 per cent. of its full speed, the machine has a cruising speed of 90 miles an hour.

Work on the development of stainless steel floats was continued during the year. A pair of these floats, riveted by means of a special type of rivet produced by the company, is now under test on an "Osprey" machine. As an alternative to riveting, an experimental stainless steel float is now under construction, in which the fastening is effected by the Budd process of shot welding.

The Bristol Aeroplane Company, Ltd.—In the Bristol Company's aircraft department the work of the year consisted mainly of the production of "Bulldog" single-seater fighters and "Bulldog" two-seater advanced training machines. Important experimental work was also carried out, of which the results may shortly be available for general information.

In the engine department the quantity production of "Pegasus" and "Mercury" radial air-cooled engines was continued on an increasing scale, but the chief event of the year was the development of two new types of Bristol engine, namely, the "Phœnix" compression-ignition engine and the "Perseus" air-cooled sleeve valve engine. We illustrate these two interesting and important engine developments herewith.

The "Phœnix" engine represents the outcome of seven years of intensive work on compression-ignition engines conducted by the company's engine research department on behalf of the Air Ministry. For five years research was carried on with single-cylinder units, some of which were run for over 1500 hours. Following an official type test of one of these single-cylinder units, it was decided to produce an engine having the same general lines and the same capacity—namely, 28·7 litres—as the Bristol "Pegasus" engine. This engine has been undergoing development during the past eighteen months and has run for about 200 hours on the test bench. For some weeks past it has been tested in flight on a Westland "Wapiti" general purpose machine with, we are informed, highly gratifying results as regards ease of starting, smoothness of running, and general performance. Excessively high maximum explosion pressures have been avoided and the fuel used is of the ordinary commercial variety of about 0·85 specific gravity, as used by the Admiralty and for transport lorries and generally obtainable throughout the world. The engine has nine air-cooled cylinders working on the four-stroke cycle. Its maximum output is 400 B.H.P., the cruising power being 350 B.H.P. at the normal speed of 1900 r.p.m. The net dry weight is 990 lb. and the overall diameter is 53in., or 2in. less than the "Pegasus" petrol engine. For comparison purposes it is interesting to note that the "Phœnix" has the same weight as the 600 H.P. "Pegasus" engine. The power is one-third less, but the cruising fuel consumption per horse-power hour is 25 per cent. lower.



BRISTOL "PHOENIX" AIR-COOLED C.I. AND "PERSEUS" AIR-COOLED SLEEVE VALVE ENGINES

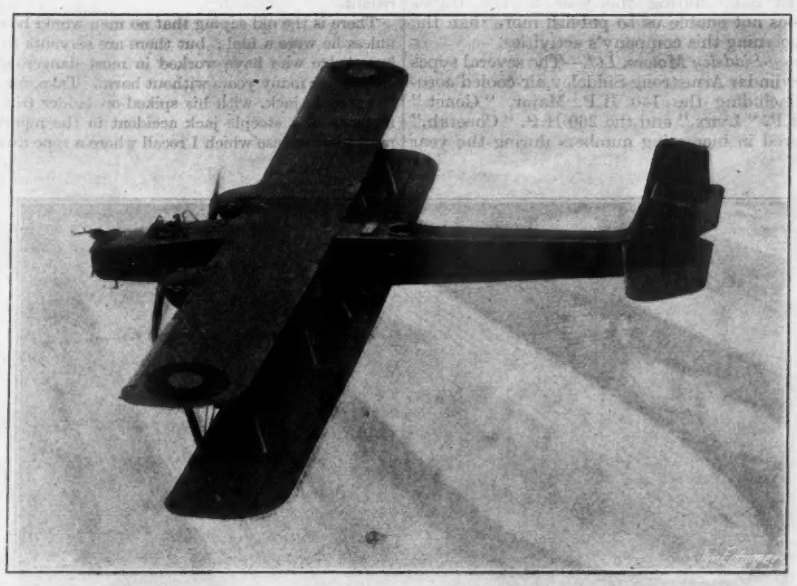
The "Perseus" air-cooled sleeve valve engine is the outcome of eight years of development work conducted with the active support of the Air Ministry.

As in the case of the "Phœnix" engine, the experimental work was conducted at first with a single-cylinder unit, several designs of which were made and tested on the bench, several thousands of hours' running being accomplished before the complete engine was constructed in 1932. In July, 1933, this engine completed a highly satisfactory 100 hours' type test on the bench. During this test the engine ran without any adjustments being made and without even the replacement of the sparking plugs. This test was followed by a fifty hours' weak mixture test and a fifty hours' high-power test. The engine is now undergoing flight trials, and up to the present, we learn, has given as satisfactory results in the air as on the bench. It has a capacity of approximately 25 litres and gives, we are informed, a higher power output and a lower fuel consumption than have ever been recorded in connection with an air-cooled overhead poppet valve engine of similar type. Other sleeve valve radial air-cooled engines are engaging the attention of the company, the highest importance being attached to this type in connection with the company's future engine development programme.

The Blackburn Aeroplane and Motor Company, Ltd.—The outstanding product of the Brough works was undoubtedly the "Perth" flying-boat illustrated herewith. This machine, the largest military flying boat in production in this country, has been adopted by the Royal Air Force for coastal defence duties against hostile surface or submarine craft. Alternatively, it may be employed as an escort for merchant vessels or for reconnaissance in conjunction with the fleet. It is designed to operate for extended periods away from a base, and to that end is provided with roomy living and sleeping quarters, stowage for kit and food supplies, canteens, and cooking equipment. Its armament consists of three machine guns, a load of about 2000 lb. of bombs, and an automatic quick-firing gun, projecting from the nose of the hull, capable of firing 1½ lb. shells. The machine carries a crew of five and a normal supply of 1000 gallons of fuel. Fully laden, it has a total weight of 14½ tons, but with extra supplies of fuel, &c., its total weight may be as much as 17 tons. At sea level it has a maximum speed of 115 knots, and it can climb to 10,000ft. in 22 min. At a speed of 95 knots it has a normal range of 898 miles, but with extra fuel supplies this figure may be increased to 1496 miles. The engines are three Rolls-Royce "Buzzards," each developing 825 H.P., and each fitted with a water tank and two radiators arranged for water or steam cooling interchangeably. Hand turning gear is provided for priming the engines. The actual starting of the engines after they have been primed is effected by means of air bottles, starting magneto, and other equipment controlled from the rear gunner's cockpit. Petrol is supplied to the engines by gravity feed from three tanks, each containing 575 gallons slung underneath the top plane. All the fuel tanks, cocks and piping are arranged externally to the hull to reduce the risk of fire to a remote contingency. The machine throughout is constructed almost entirely of duralumin, Alclad, and stainless steel.

The bow cockpit is open and from it the quick-firing gun—or, alternatively, a Lewis gun—is operated. Through a door at the rear of this cockpit the enclosed control cabin is reached. This cabin has two side-by-side seats. Immediately aft comes the navigator's station—the navigator also acts as a gunner or a second pilot—and behind it is the officers' ward-room, fitted with hinged pneumatic settee berths and a hanging table. With the berths and table in the stowed position a clear space of about 7ft. square by 6ft. high is available in the ward-room. Aft of the ward-room is the engineer's station—the engineer also serves as a gunner—and still further aft comes the men's sleeping quarters equipped with three folding bunks. In this compartment an inflatable dinghy is stowed. Behind the men's quarters is an enclosed wireless cabin and a kitchen fitted with a paraffin cooking stove, an ice chest and other equipment. From this portion of the hull the rear gunner's cockpit, situated behind the trailing edge of the lower plane, is reached by a ladder. This cockpit serves as the main entrance to the whole of the hull. Beyond the kitchen there is yet another compartment containing a lavatory. Through a door in a watertight bulkhead, access is gained to a walkway extending along the remainder of the hull interior to a cockpit at the extreme tail end, which is equipped with a machine gun. The various compartments into which the hull is divided are separated from each other by watertight bulkheads, rising to half the height of the hull and fitted with swing doors.

Handley Page, Ltd.—The "Heyford" express night bomber illustrated herewith represents perhaps the greatest departure from standard design which we have to record this year. Its most striking feature is to be found in the position of the fuselage. Our engraving does not make this feature very clear, but it may just be seen from it that the fuselage abuts against the underside of the *top* plane. The two engines abut against the same surface. From the engine nacelles and the fuselage struts extend downwards to the lower plane. The machine may, in fact, be described almost as a high-wing monoplane, with an additional wing hung beneath it. The arrangement is stated to be very efficient aerodynamically. The arrangement of the machine is the fact that the high position of the engines permits the armourers to reach the bomb cells for replenishment when the machine is on the ground without risk of their being struck by the air screws. The machine is undoubtedly a formidable weapon. It has been adopted by the Royal Air Force as a standard design and is now replacing older types of bomber.



HANDLEY PAGE "HEYFORD" EXPRESS NIGHT BOMBER

BLACKBURN "PERTH" COASTAL DEFENCE FLYING BOAT

The metal, and is driven by two "Kestrel" engines. Its normal crew numbers four. It is equipped with an automatic pilot, a vertical camera, and a complete wireless installation. At an altitude of 12,500ft. it has a maximum speed of 142 m.p.h. Its service ceiling is 20,000ft. With a bomb load of 1598 lb., it can cruise for 920 miles at a height of 10,000ft., and at a speed of 115 m.p.h. At the same height and speed it can cruise for 400 miles with a bomb load of 3143 lb. The undercarriage arrangement consists of two wheels faired into the underside of the lower plane vertically beneath the engines. The wheels are separate and are not united by an axle. This arrangement leaves the whole of the central section of the lower plane between the wheels unobstructed. In this section the bombs are carried in cells closed by spring-loaded doors. The bombs are therefore not exposed to the air stream, a fact which materially reduces the resistance of the machine when in flight and fully loaded. An important feature of the general

pilot, situated in a cockpit well in front of the leading edge of the top plane, has an exceptionally unrestricted field of view. The two gunners' cockpits, visible in the engraving, leave undefended a considerable field beneath the machine, but they are supplemented by a third gun which is mounted in a rotatable turret, projecting from the underside of the fuselage a little to the rear of the upper after-gunner's cockpit. This turret can be retracted within the fuselage when it is not in use. The machine is constructed entirely of

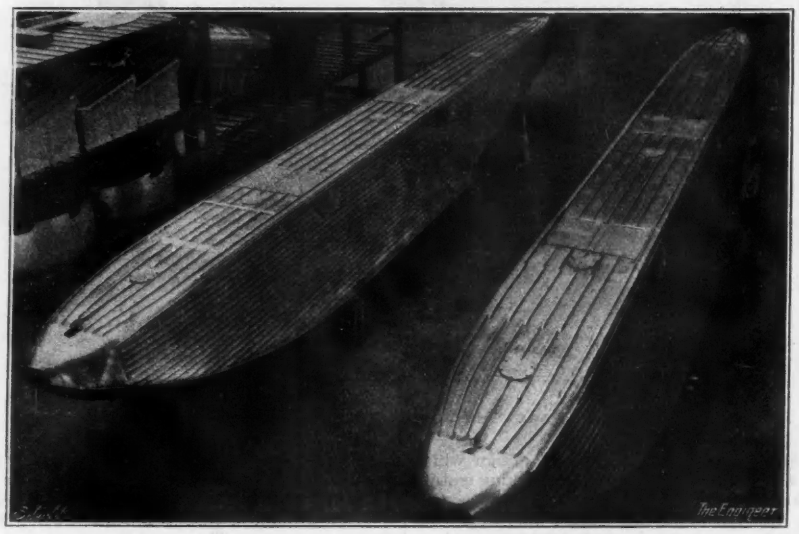
The Fairey Aviation Company, Ltd.—The Fairey long-range monoplane specially built for the Air Ministry, which we described and illustrated two years ago, succeeded in breaking the world's long-distance, non-stop record in February, 1933, by flying from Cranwell to South Africa, a distance of 5309 miles in 57 h. 25 min. Great Britain has since been deprived of this record by subsequent achievements, but the performance, nevertheless, remains a remarkable and meritorious one. The design of this long-range monoplane may be regarded as having led directly to that of the Fairey long-range night-bomber which we illustrated a year ago. The single engine of the earlier machine, mounted at the nose

of the fuselage, was replaced in the bomber by two engines built into and projecting from the leading edge of the wings. The engines can, presumably, be reached when the machine is in flight by means of passage ways inside the thick cantilevered wings. The nose of the fuselage in the bomber contains three cockpits, while two other cockpits are provided, one near the rear edge of the wings, and another right at the tail.

The Fairey "Gordon" two-seater general purpose machine and the "Seal," a modified version with three seats employed for Fleet Air Arm work, were supplied in large numbers to the Royal Air Force, and to a number of foreign countries. Both these types underwent development, and are now fitted with balanced flying controls, which have still further increased their manœuvrability and lightness of control. During the year the company received additional contracts for the supply of "Fox" and "Firefly" machines to the Belgian Government. It is to be regretted that the secret nature of some other work done during the year at the Hayes factory does not enable us to publish more than the above concerning this company's activities.

Armstrong-Siddeley Motors, Ltd.—The several types of seven-cylinder Armstrong-Siddeley air-cooled aero-engines, including the 140 H.P. Major, "Genet" the 215 H.P. "Lynx," and the 260 H.P. "Cheetah," were ordered in increasing numbers during the year for the latest designs of training machines. For the "Genet" engine a hand-electric starter, operated in conjunction with an ignition coil and a wireless telegraphy battery of 50 ampère-hours capacity was evolved. A self-regulating diaphragm petrol pump, giving constant pressure on the delivery side, was also produced for the same engine. These two developments can be fitted to other engines of the company's manufacture. The engines of higher power produced at the Coventry works were also developed in certain respects. The ten-cylinder 340 horse-power "Serval" engine is now available in an ungeared as well as a geared form. The fourteen-cylinder "Panther" was produced with new high-speed cylinders and improved valve gear, and now develops 560 H.P. at its normal speed of 2100 r.p.m., when at an altitude of 5500ft. In a supercharged form, it is capable of developing 540 H.P. at 12,000ft. The fourteen-cylinder "Tiger" was also developed. At the moment it is rated at 640 H.P., but it is expected that its power will be considerably increased in the near future.

Sir W. G. Armstrong, Whitworth Aircraft Company, Ltd.—At the Whitley aircraft works the A W XVI., a single-seater with a top speed of about 200 m.p.h., was the subject of continuous development during the year. In one form it has now been produced as a fleet fighter, and in another as a day and night fighter. Among other developments, the company paid close attention to stainless steel floats for seaplanes. It claims to be the pioneer in the development of this form of float, two examples of which are illustrated herewith. Stainless steel floats, it now seems to be established, are capable of giving a much longer life than floats of any other metal, and of providing the same buoyancy for approximately the same weight. The company also undertook important work on the development of metal propellers and on engine cowling.



ARMSTRONG-WHITWORTH STAINLESS STEEL SEAPLANE FLOATS

We have to acknowledge our indebtedness to our contemporary *Flight*, for granting us permission to use the copyright photographs of the Blackburn "Perth" flying-boat and the Handley Page "Heyford" bomber reproduced above.

A FACTORY capable of producing 10,000 tons of tin plate annually has started work at Sarnia, Ontario.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

FOOL-PROOF MECHANISM AND FOOLS.

SIR,—The recently issued report on industrial accidents of his Majesty's Inspectors of Factories, induces some thoughts, and the first one is that to no mechanism can be applied the colloquial expression of "fool proof." That report contains numbers of instances of accidents where, from an engineer's point of view, the machinery has been reasonably safe as regards the operators, but they (the operators) have succeeded in getting themselves injured. I do not suggest that, in all cases, they have done so deliberately, neither do I admit that all employers guard their machinery fully; but I feel that as often as not the employee is to blame, and that it should be the aim of our mentors to make those workers more self-reliant.

There is the old saying that no man would be a servant unless he were a fool; but there are servants to my own knowledge who have worked in most dangerous circumstances for many years without harm. Take, for instance, the steeple jack, with his spiked-on ladder (there is one instance of a steeple jack accident in the report), and a most glaring case which I recall where a rope drive passed over a passage way unguarded, below head level, in an engineering workshop, but resulted in no accidents.

These are, of course, cases where people with reasonable intelligence are concerned, and they should be expected to take care of themselves from experience, or, shall I say, association.

One never hears of a monkey bargee's child being drowned, although they are free from their earliest youth to fall over the side. They learn, intuitively, that it is safer on deck than in the water. On the other hand, we read of some one who has put his foot under the guard of a piece of moving machinery, and had his toes mangled. Presumably, he relied on the guard being effective.

Would it not be better if the worker were to rely on his own intelligence to keep himself out of mischief, rather than upon some outside person? It is to be admitted that many machines are attended by people of comparatively low intelligence, but all have the instinct of self-preservation, and observation is the first principle of self-preservation.

The work carried out under the ægis of the Home Office by H.M. Inspectors of Factories may be necessary and salutary, but would not the expenditure be better devoted to, shall I say, "parental" training of children in taking care of themselves? PHILIP.

January 8th.

RAILWAY COLLISIONS.

SIR,—As you are probably aware, the *Daily Express* is keenly agitating for the replacement of wooden railway coaches by those of steel construction. Convinced as I am that the casualty rolls of railway collisions would not be diminished by such substitution, I wrote to the Editor of that paper on the 27th inst., expressing the opinion that it is very questionable whether, had the trains involved in the recent appalling accident in France been both of steel structure, the casualties would have been any less terrible; my reasons being that impacts, however stupendous, will exact their toll to the utmost farthing; that the disintegration of the wooden coaches of the stationary train saved the lives of the passengers in the oncoming train composed of steel coaches; that, had both trains been composed of wooden coaches, the casualties would have been distributed between both trains, and modified in severity accordingly, *i.e.*, fewer killed, more injured; had both trains been of steel structure, conceivably few passengers of either train would have escaped serious injury; that it is bad enough to have human bodies jammed in woodwork; but, in this case, wood saws to release them are generally readily procurable; but there is small hope of release for those caught in a mass of tangled and buckled steelwork.

He has ignored my letter, and I am writing to you, Sir, hoping that my appeal to you will meet with more sympathetic reception, and that you will give full and fair publicity to opinions submitted to you on this most important question.

ALBERT E. BENNETT,
A Fellow of the Physical Society.

London, S.E.20, December 29th.

"QUALITY *versus* PRICE."

SIR,—With reference to the paragraph under this heading, contained in your leading article "A Retrospect," in the issue of January 5th, 1934, page 15, unfortunately the statement made does not go back far enough to the origin of the trouble.

Five-and-twenty and thirty years ago British-made machinery was to be found not only in the railway equipments in the Argentine, but many of the engineering equipments—electrical, waterworks, gas, &c.—were also of British manufacture. Then came the time when Americans, overflushed with money and eager to have an export trade, bought up a number of the electricity supply stations, and the Germans and other Continental firms—under subsidies and overseas dumping prices—made a price-cutting cockpit of this territory, which British manufacturers, with their overburden of high taxation and manufacturing costs were unable to compete with.

These now American-owned power stations buy their machinery on price, and, with the changed conditions in the United States, there is very good reason to believe that the Argentines will take advantage of the opportunity they now have of either buying out the foreigners on their own terms, or putting down their own independent power plants and supplying electricity at much cheaper rates than the big power companies can do.

JOHN BELLISS.

Birmingham, January 8th.

BLAST NOZZLES.

SIR,—In going through some of the laboratories of the Technical High School at Charlottenburg, I was struck with a relatively simple piece of apparatus for exploring the correct proportion of the blast nozzle and smoke-box of locomotives.

The professor told me that they had obtained valuable results from it.

It interested me particularly, as I had advocated some time ago the setting up of a similar apparatus for this important field of research.

If the complete Locomotive Research Laboratory could not go through, we might carry on the investigation of important details of design on small scale, relatively inexpensive, pieces of apparatus.

The practice in blast nozzle and smoke-box design is so widely different, so much, at any rate, in the finer adjustments, one of trial and error, that there is an ample field for discovering increase of efficiency with reduction of back pressure and fuel consumption. Divided nozzles, variable nozzles, higher automatic increase, multi-jet, and even others, from the staccato blast of the reduced nozzle, small boiler type, to the low-pressure discharge of the Swedish turbo locomotive.

It would be a pity to wait for the Germans to again tell the world how they had investigated precisely and now know how to produce the most efficient form, as they seem to be doing for very high speed trains.

ALAN CHORLTON.

London, S.W.1, January 8th.

PUBLICATIONS OF THE NATIONAL PHYSICAL LABORATORY.

THE following is a list of papers read or published from the Laboratory during December, 1933:—

Papers Read.

"Heat Transfer between Metal Pipes and a Stream of Air," by E. Griffiths and J. H. Awbery, Institution of Mechanical Engineers, London, December 15th.

"The Valve Maintained Tuning Fork as a Primary Standard of Frequency," by L. Essen and the late W. D. Dye, the Royal Society, London, December 14th.

"Leakage Phenomena in Ring Type Current Transformers," by A. H. M. Arnold, Institution of Electrical Engineers, London, December 1st.

"Current Transformer Testing," by A. H. M. Arnold, Institution of Electrical Engineers, London, December 1st.

"The Electrical Properties of Sea Water," by R. L. Smith-Rose, the Royal Society, London, December 14th.

"The Lighting of Docks," by J. S. Preston, the Illuminating Engineering Society, Liverpool, December 6th.

"Mutual Interference between Parts of Aircraft," by E. Ower, the Royal Aeronautical Society, Bristol, December 5th.

Papers Published.

"A Symmetrically Opening Optical Slit," by J. E. Sears, jun., *Journal of Scientific Instruments*, Vol. 10, No. 12, page 376.

"An Automatic Counting and Timing Mechanism for Testing Electricity Meters," by A. Felton, *Journal of Scientific Instruments*, Vol. 10, No. 12, page 369.

"Research Work on Dental Amalgams," by C. H. Desch, *British Dental Journal*, No. 55, page 605.

THE INSTITUTION OF MINING ENGINEERS.—The medal of the Institution of Mining Engineers, the highest distinction in its power to confer, has been awarded to Mr. H. Eustace Mitton, M.I. Min. E., of Derby, in recognition of his services to the mining engineering profession and to the Institution of Mining Engineers.

Bench Lay-out in an Electrical Repair Shop

By L. I. HUNT.*

THE Institute is at present engaged upon an investigation in a factory, one section of which is devoted to the repair of complex electrical equipment. This work is in many ways the very antithesis of "mass" production, and in interest and variety leaves little to be desired even by the most ardent belittler of modern production methods. Craftsmanship to-day, however, owes much to the necessity for precise measurement and standardisation which the factory system imposed upon the older methods of work; and in this particular instance the Institute is endeavouring to increase the regularisation of operations without in any way impairing the freedom of the individual operator.

The equipment in question is dismantled, repaired and reassembled upon benches of orthodox design; and when the investigation began the Institute felt that attention to the general tidiness of the bench, standardisation in the placing of tools, ease in the handling and storage of these, and the convenient placing of small parts in constant use, would be well rewarded by an increase in the general efficiency of the workers. Further, there were several interesting points attaching to the storage of small parts in occasional demand, and to the safeguarding of tools, such as files and chisels, which are prone either to cause or to suffer damage.

The Handling of Small Tools.

Three or four small tools are used more often than any others in the types of work most frequently performed; and the workers tend to place these tools on the first clear patch of bench which can be seen in a hurried glance during their use. Such clear patches rarely occur on the part of the bench nearest to the work, and this habit also necessitates the effort of looking for each tool every time it is required. Moreover, these small tools are often covered and hidden by larger tools which have been used and put down since the small tool was placed on the bench.

The Placing of Small Parts.

Small parts, such as screws and nuts, are in frequent demand in many types of assembly work, and in this factory they are kept on the bench in the same paper in which they have been issued from the stores, and are placed as near to the work in progress as the other things on the bench will allow. In consequence, the worker often has to reach over the top of the instrument upon which he is working in order to reach the screws which he requires for each part he fits, so that awkward movements are frequently repeated.

The Storage of Small Parts.

There are also a number of small parts which the men are in the habit of saving from instruments which they have had to scrap, but which are not worth the trouble of entering up and booking which is involved in returning them to the stores, and they sometimes over-estimate the number of parts which they will require on one job, the remainder likewise not being worth the trouble of returning to the stores. Furthermore, as each man deals only with one type of instrument for long periods, he comes to know the slight differences between units made by different makers to the same specification (issued by the company) and he likes to keep parts from such units under his own control in readiness for the next set of instruments of the same kind, instead of returning them to store, where their identity would be lost among other parts of the same specification, but not necessarily made by the same manufacturer.

The present method of keeping such parts is to use a deeply partitioned drawer turned on its side, and to put in it small cardboard boxes or tobacco tins to hold the different parts and to prevent them from being overlaid with dust. This practice has several drawbacks. The bench, as shown in Fig. 1, looks very untidy, as two or three drawers or wooden cases of different kinds may be placed on the same bench, and filled with a hotch-potch of different boxes and tins; further, such drawers and cases take up room on the bench which could be better employed. The psychological effect on the men is to countenance slovenliness, and they themselves brought the matter to the Institute's notice on that ground. Moreover, it is difficult to decide just how much of this "reserve" stock the men shall be allowed to keep, and very varying quantities are, in fact, stored by different men.

A Storage Cabinet Recommended.

The Institute has therefore recommended the introduction of a new type of cabinet on the benches, together with an adjustable tool holder, and an adjustable tray for holding the small parts which are in continual demand. This cabinet is shown in Fig. 5 and in the photograph Fig. 2. It is 36½in. in length and has a set of six shelves, together with a set of upright partitions in which requisition books and the like may be kept. The whole cabinet is raised 6in. above the level of the bench, so that this bench space is released for work in progress; and the top is broader than the tops of the former boxes, thus providing more space for the temporary storage of larger items. On the right-hand side of the cabinet is a double shelf for the larger tools, some of which are better out of the way during much of the assembly work, but which are still too frequently in demand to permit of their being put away in a drawer every time they have been used. This tool rack, as will be seen from the illustration, is designed to allow the tools almost to be thrown in, and to hold them with the handle towards the worker to facilitate his picking them out when they are once more required.

An Adjustable Holder for Tools and Small Parts.

To look after the two or three small tools which are in constant demand, the Institute has recommended the adoption of an adjustable arm, shown in Fig. 6, mounted on a steel column, and having at its end a tool holder, shown in Fig. 7, consisting of three "pockets" in which tools can be placed with a minimum of attention, and in which they will be held in the most convenient position for being picked up again. This holder can be so arranged that the tools are held just under the hand of the worker when he is working on a large instrument, and will prevent them from being lost among the other material on the bench whenever they are put down.

A similar arm has been recommended on the left side of the bench to take small boxes of parts in constant demand, which can similarly be placed so that these parts are held within very easy reach of the worker.

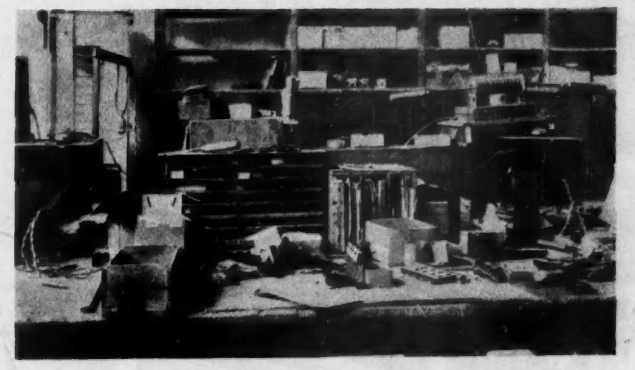


FIG. 1—*Original Bench, showing Miscellaneous Cases, Boxes and Tins*

FIG. 2—*Experimental Cabinet with Tool-holder and Tray, on Adjustable Arms*

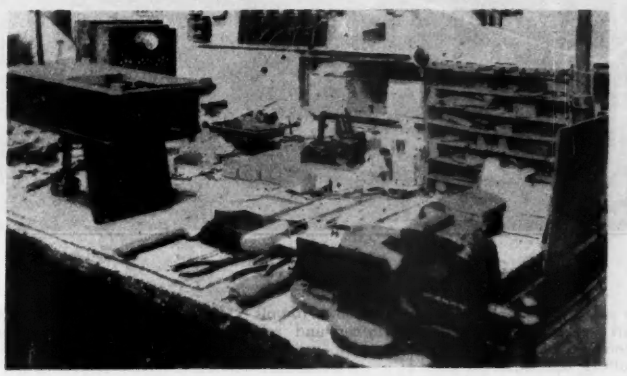


FIG. 3—*Original Bench in Second Shop*

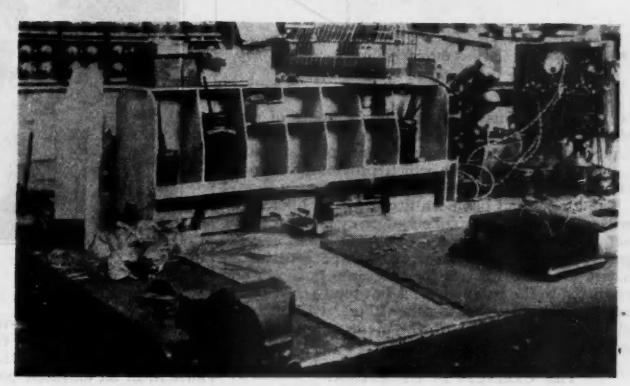
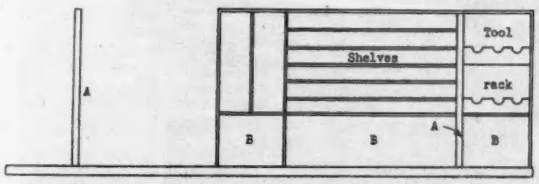


FIG. 4—*Experimental Cabinet in Second Shop*



A Steel Column for Adjustable Tool-holders B Clear Bench Space Under Shelves

FIG. 5—*Storage Cabinet for Standard Bench (not to Scale)*

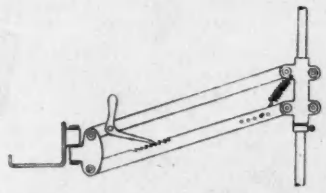


FIG. 6—*Adjustable Stand for Tool Tray*

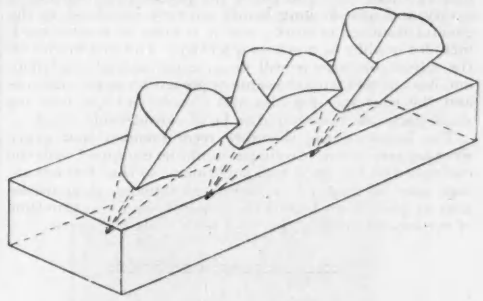


FIG. 7—*Holder for Small Tools—intended to be Mounted on a Flexible Arm (not to Scale)*

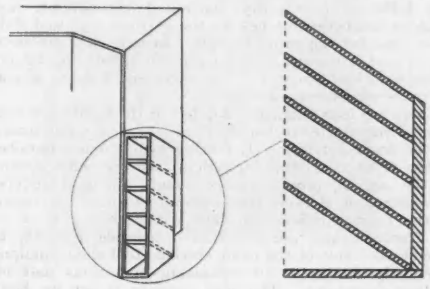


FIG. 8—*New Tool Box (not to Scale)*

* Reprinted from "The Human Factor," by courtesy of the National Institute of Industrial Psychology.

The experimental introduction of this cabinet and its accompanying adjustable arms brought to light another problem: to make some provision for storing files and chisels so that the worker could pick them up and have them ready for immediate use without the need for further adjustment in his hand to secure a good grip. This problem was solved by the construction of a container (see Fig. 8), composed of a set of four compartments, 2in. square, mounted one upon the other, and sloping upwards towards the operator at an angle of about 30 deg., the back of the box being made of ¼in. deal, and the shelves and sides of four-ply. The position in which tools were held by this container can be seen by reference to Figs. 2 and 4, where it appears on the right-hand side of each cabinet.

A SECOND CABINET INTRODUCED.

The same general problems which have been stated above were met in another shop in the same factory, where the type of work done is very similar to that done in the first, the only significant differences being due to differences in the instruments repaired. In this shop (as may be seen from Fig. 3) there was a very definite need for a cabinet which would provide neat and adequate storage space for parts which have to be returned by the worker during the progress of other operations, and the Institute therefore recommended the introduction of a cabinet 30in. in length, 8in. in width, and 12in. in height, which is

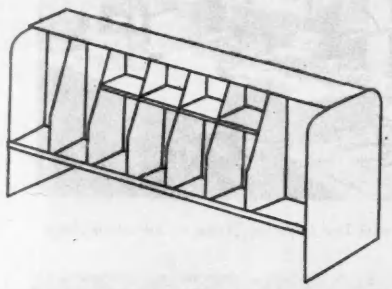


FIG. 9—*New Storage Cabinet introduced in the Second Shop (not to Scale)*

provided with partitions to accommodate boxes of parts not in immediate use, parts which are being held pending the completion of other operations, and pots of paint, enamel, and other equipment which previously found a home on the bench itself. This cabinet is shown in Figs. 4 and 9. The lower shelf has been fitted with a hinged rib, which will serve to contain spherical or cylindrical parts, but which may be lowered for cleaning the shelf, and the upper partitions, which are reserved to the centre four sections, are made to lift out for the same purpose, and have a rib fitted to the front edge. A flat top to the cabinet provides space for a number of other items, without being so broad as to invite abuse by being made to hold large or heavy goods.

THE CABINETS IN OPERATION.

Two cabinets of the first type and one of the second type have been constructed and placed in operation, and one of the first type has been fitted with adjustable tool holders and trays. The cabinets themselves have met with the unqualified approval of the workers, and the appearance of the benches has been enhanced. Reliable figures to indicate increased efficiency are impossible to obtain on such irregular work, but apart from the direct saving of time which results from reducing the frequency of misplacing small tools and parts, the psychological effects of a tidy and neat-looking bench are very beneficial to the general standard of work—which, it must be remembered, includes quality as much as quantity. The tool holder on the adjustable arm is still in an experimental condition, and has not met with the same appreciation as the cabinets and the container for files and chisels, but the tray for small parts has been found to be of considerable value.

The Institute has therefore recommended that every working position in the shops should be equipped with the cabinets and the fixed tool containers, so that full advantage may be reaped from increased tidiness, standardisation in placing tools and components, and the provision of convenient storage space for both tools and parts.

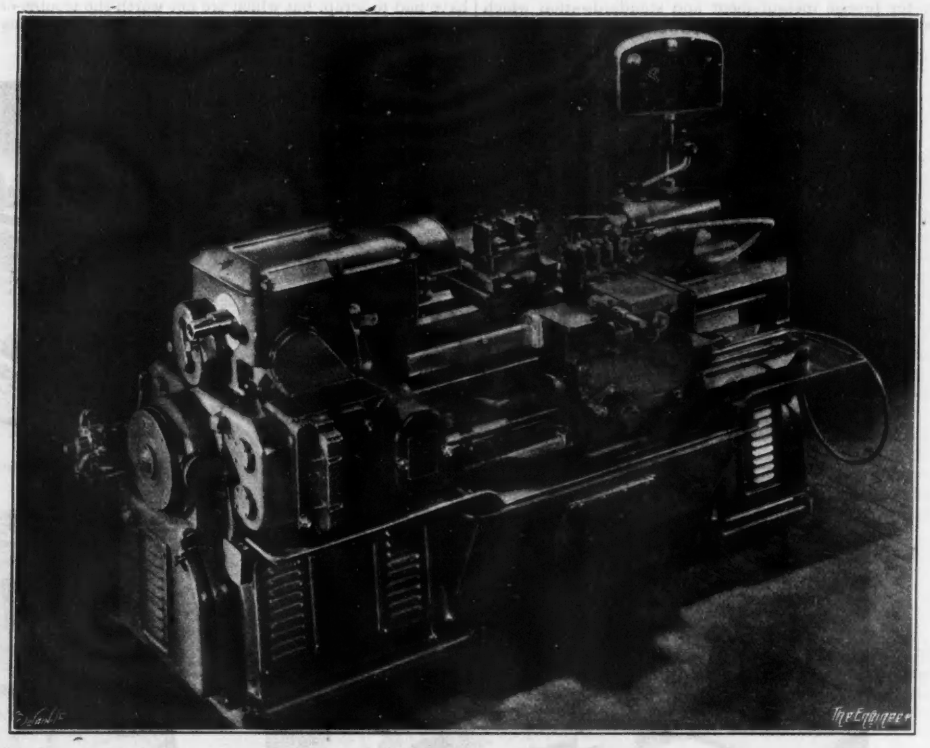
The "Magna-Matic" Automatic Lathe.

THE machine illustrated herewith, known as the "Magna-Matic" automatic lathe, is a recent production of the Monarch Machine Tool Company, of Sidney, Ohio. This machine is claimed to employ entirely new principles in automatic lathe construction, control, and operation. The lathe is electrically controlled throughout, and employs magnetic clutches for the carriage and tool slide feeds, and for the rapid traverse, as well as a magnetic clutch and a magnetic brake for the spindle operation. Limit switches control the diameters and lengths of cut. No cams whatsoever are used.

There are four magnetic clutches in the front gear-box. Two of them provide longitudinal feed and rapid return to the front carriage. The other two magnet clutches in the front gear-box, through a feed rod and gearing in the apron, provide in-feed and out-rapid-traverse movement, or in-rapid-traverse and out-feed movement to the front carriage tool slide. A reversing lever on the front carriage apron makes it possible instantly to reverse the cycle of the front carriage tool slide—making it equally adaptable to out-facing operations and in-feeding operations. The rear carriage is set by hand at any point along the bed. Its tool slide is controlled automatically by two magnet clutches contained in the rear gear-box. They provide in-feed for facing or necking operations and out-rapid-return. The front and rear gear-boxes give a range of seven feeds, varying between 0·0046in. and 0·0414in. The rapid-traverse-return is at the rate of 70in. per minute to both the tool slides and to the front carriage.

The headstock spindle is driven through gearing and chain. A high and low gear ratio of 4·4 to 1 is controlled by means of a lever on the front of the headstock. The change-speed gearing gives a normal range of twelve spindle speeds varying between 41 and 610 r.p.m. This range can be stepped up or down as desired, either by varying the speed of the main driving motor in the headstock cabinet leg, or by changing the diameter of the multiple vee belt sheave pulley on the motor. The spindle may be safely operated at 1500 r.p.m.

The tailstock spindle has an anti-friction, built-in



AN AMERICAN AUTOMATIC LATHE

tailstock centre. One lever both positions and clamps the tailstock spindle. The front carriage and tool slide are so arranged as to pass the tailstock. The master control switch, in an elevated position above the tailstock, gives complete electric control for both the setting up and the full automatic operation of the machine. The main starting button starts the feeds to both the front and rear carriages in addition to starting the spindle. One reverse button will reverse both carriages at any point in the operating cycle, the carriages returning quickly to the original starting position. Another button controls the front carriage and provides inching movement to the front tool slide and carriage for convenience when setting up. Another button gives an inching movement to the rear tool slide. The rear carriage tool cycle can be timed to begin before or after or at any intermediate instant in relation to the front carriage tool cycle.

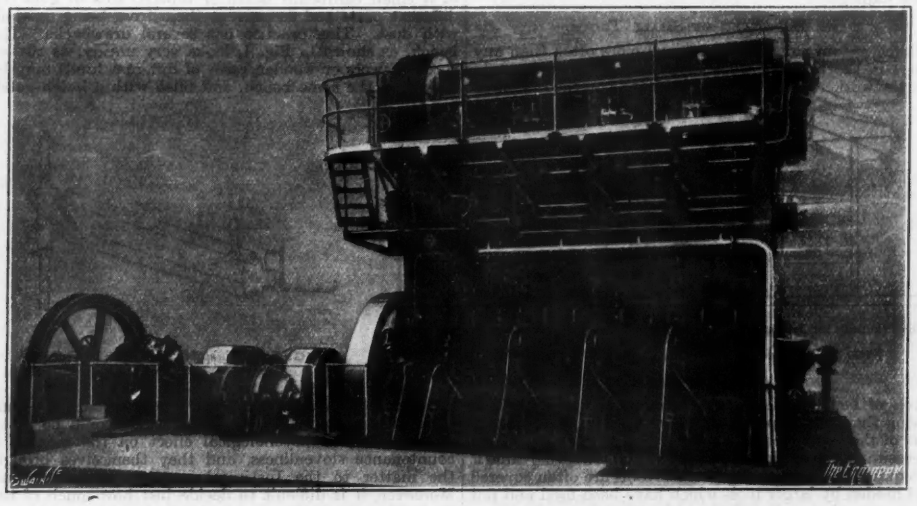
The carriages and tool slides are automatically oiled by a forced feed lubrication system. The headstock, as well as both the front and rear change gear-boxes are all automatically lubricated by means of an oil pump, which circulates oil to all operating parts in these units from a reservoir in the lathe bed.

The lathe, when desired, may be operated to turn various diameters and lengths by means of a single point tool on the front carriage. All the tool movements are controlled by means of a template of steel from ⅛in. to ¼in. thick. This template is held in a bracket bolted to the front carriage vee at the headstock end of the lathe. A two-way electrical contactor switch makes contact with the template and will, it is stated, reproduce the shape of the work on a production basis to within 0·001in. The diameters and lengths, turned by the front tool, are controlled entirely from the template. The rear tools can be used for facing and necking simultaneously, the rear tools being timed to perform their work at any desired point in the front carriage tool cycle.

The machine can be equipped with an automatic feed step-up for the front carriage. This mechanism consists of a simple electrical control permitting the automatic selection of the desired rate of feed on as many as four different diameters of a shaft or piece of work. To operate the magnetic clutches approximately 1 kW of 115-volt D.C. current is required. The limit switches and relays operate on 14-volt current, thus avoiding any tendency to arcing in the switches.

1000 B.H.P. Oil Engine.

IN connection with the extension of its plant at Birmingham, the British Oxygen Company, Ltd., has purchased from Harland and Wolff, Ltd., a totally enclosed, four-stroke, airless-injection, trunk piston-type engine, having four cylinders, each 550 mm. diameter, with a 1000 mm. stroke, and designed to develop its rated power at 175 r.p.m. The cylinder liners and covers are water-cooled, while the pistons are cooled by lubricating oil. All the bearings are pressure-lubricated. The engine-driven lubricating oil pump draws the oil from the engine sump and discharges through the filter and cooler to the



H. AND W. 1000 B.H.P. OIL ENGINE

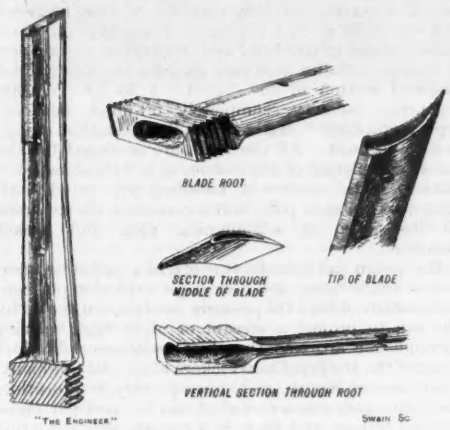
forced lubrication and piston-cooling systems. The cylinders are lubricated by mechanical lubricators. The design of the piston and connecting-rod is such that they can, as a unit, be withdrawn through the crank case door, while, as floating gudgeon pins are provided, the separating of the piston and connecting-rod is a relatively simple operation. Both the inlet and exhaust valves are operated by levers from the cam shaft, while the fuel valves and air starting valves are automatic in their

action, the cam shaft being chain-driven from the crank shaft. There is one fuel pump to each cylinder, the pump being of the pressure-injection and spill type, and governing the fuel valve timing. A balanced crank shaft is employed.

The Parsons Hollow Turbine Blading.

BY devising a method of manufacturing turbine blades hollow from end to end, C. A. Parsons and Co., Ltd., have once more been responsible for a notable advance in the construction of steam turbines. The effect of this new development is to bring about a substantial reduction in the weight of the blading, and therefore to permit of higher blade speeds and consequently of greater outputs, without increasing the stresses. It has long been recognised that the power which can be efficiently generated by a turbine running at a given number of revolutions per minute is limited by the area available for the flow of steam through the last rows of blades. This area, in turn, is limited by two considerations: firstly, that the necessity for avoiding excessive differences of blade pitch forbids the blade length exceeding about one-third of the wheel diameter; and secondly, that prudence with regard to centrifugal forces limits the permissible velocity of the blade tips. The velocities in common use make it essential to taper the blade profiles, so that the cross section at the tip is appreciably smaller than that at the root, although regard for the proportions of the steam passages obviously limits the amount of tapering that can be adopted.

An examination of modern practice in connection with the low-pressure blading of steam turbines convinced Messrs. Parsons that no further advance was possible along ordinary lines of construction. The ratio of blade length to wheel diameter had been pushed to the extreme even with twisted blades, and blade tip speeds did not



PARSONS HOLLOW TURBINE BLADING

permit of any further increase consistently with safety. The one thing wanted was lighter blading. Experimental work with the various light alloys held out no hopes of progress in this direction, for none of them had the requisite strength and other qualities. High-chromium steel was the best blading material that the metallurgists had yet produced, and there seemed no prospect of finding any other material equally good.

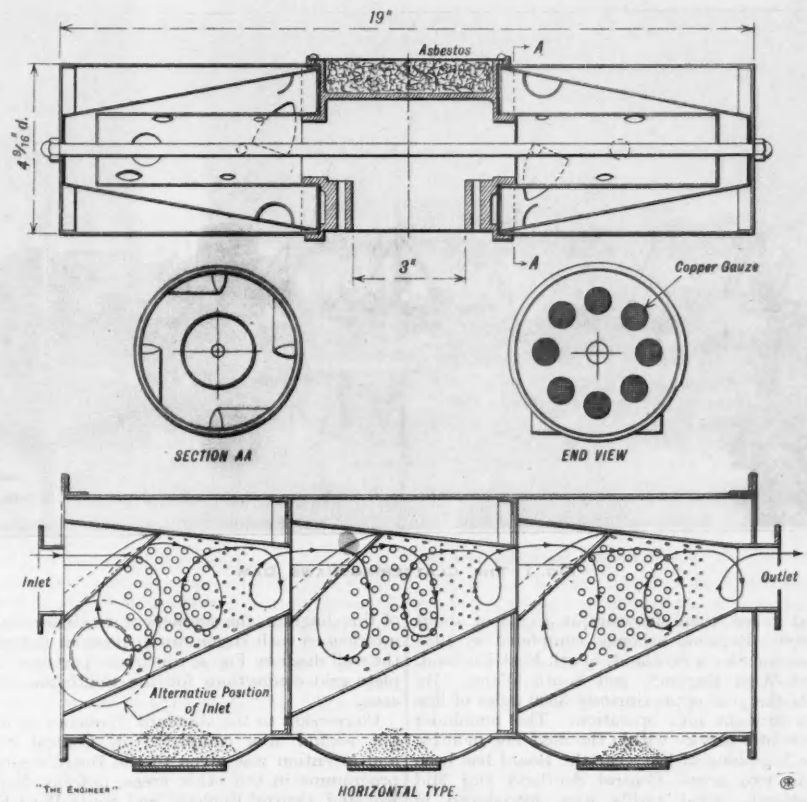
For many years it had been Messrs. Parsons' practice to manufacture their stainless steel blading by a hot rolling process, each blade being rolled integrally with its root and spacing piece, so as to conserve the continuity of the grain of the metal from end to end. The blades so formed were ideal as regarded strength and durability, and therefore the problem resolved itself into rendering them lighter in the only possible way, namely, by hollowing out the interior. Presuming that this could be done, it was obvious that a parallel hole throughout the whole length of the blade was not the best solution. To secure the maximum advantage the hole must not only be of the same shape as the blade, but it must also taper along its length so that the cross-sectional area of the metal becomes progressively less from the root to the tip of the blade, in order to obtain uniform strength.

After much experimental work, during which many difficulties were encountered, the manufacture of hollow blades, rolled from solid billets of stainless steel, is now being carried out on a commercial basis at the Heaton Works. The first of these blades were fitted, with the approval of Messrs. Merz and McLellan, and the consent of their clients, to the rotor of one of the 50,000-kW Parsons turbines now running in the Dunston power station of the North-Eastern Electric Supply Company, Ltd., and similar blades are being used in the 30,000-kW turbine for the Southwick Station of the Brighton Corporation. An illustration of one of the hollow blades, provided with the standard Parsons erosion-resisting shield, is given in the accompanying engraving. The blade in question is 17in. long overall and weighs 1¼ lb. A solid blade of the same dimensions would weigh 2 lb. Furthermore, the centre of gravity of the hollow blade is much nearer to the root than that of the solid blade. For equal centrifugal stresses, therefore, the hollow blade could be run at a speed 15 per cent. greater than that of the solid blade. Up to the present, owing to the limitations already referred to, the maximum power that could be developed with both efficiency and safety in a 3000 r.p.m. single-exhaust turbine working with ordinary steam conditions and high vacuum has been about 15,000 kW. With the new hollow blading this power can be raised to about 20,000 kW, and 40,000 kW or more can be developed in a double-exhaust turbine running at the same speed.

Although the practical significance of such results will be most fully appreciated by the designers and users of steam turbines, the solution of so difficult a problem as the production of hollow turbine blades will interest engineers in every branch of the profession. The blades are rolled individually from billets of high-chromium steel, the root being integral with the blade and the hollow formation is produced without recourse to any subsequent welding, brazing or soldering process. Moreover, the hole through the interior of the blade is of exactly the same profile as the blade itself, and tapers slightly in its length so that the walls are thinned at the top and increase gradually in thickness towards the root. By varying the wall thickness in this way the theoretical requirements for uniform strength are fulfilled without adversely affecting the external form of the blade. The manufacturing process is fully patented and has passed the experimental stage.

Silencers for Internal Combustion Engines.

THE problem of silencing both the induction and the exhaust of internal combustion engines has received considerable attention from C. G. Vokes, Ltd., of 95, Lower Richmond-road, Putney, S.W.15, and has resulted in the evolution of a number of designs, of which two typical examples are illustrated herewith.



VOKES' INDUCTION AND EXHAUST SILENCERS

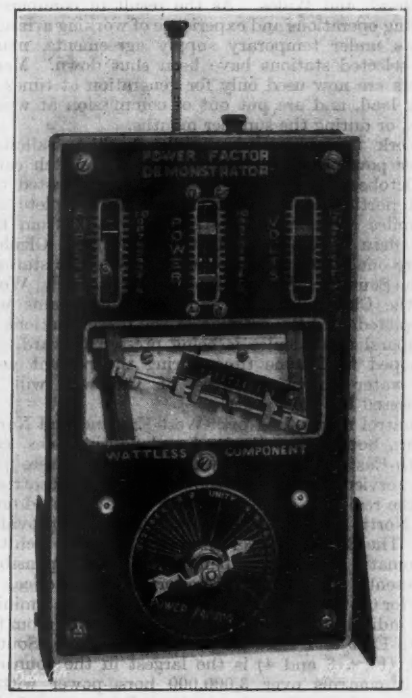
The induction silencer shown at the top of the engraving is intended for a high-speed motor car petrol engine, and comprises a central casting for bolting on to the inlet pipe, with two radial sheet steel extensions. The ends of these extensions are closed by perforated discs having copper gauze strainers sweated in behind, as shown in the end view. These openings admit the incoming air into an annular space between the outer casing and an inner truncated cone. The air flows to the end of this space, and is there admitted to the interior by openings and guide vanes that give it a whirling motion. It then passes into the central tube through perforations, which increase in size towards the ends, so as to get an even distribution of flow and prevent the gasping effect sometimes heard at the inlet to engines.

The exhaust silencer and spark arrester illustrated in the lower part of the engraving has been devised for use in conjunction with heavy oil engines and has the approval of Lloyd's Register, although that corporation prefers a water spray type of arrester for oil tankers. In it the swirling principle is again adopted. The exhaust gases first meet a deflector or baffle, and are made to follow a spiral course through an oblique cone. Any heavy sparks are thrown out through perforations in the cone, and the gases go on to two more cones in tandem. Both the silencing and spark-arresting qualities of the apparatus are said to be very effective.

A Power Factor Demonstrator.

THE task of explaining the meaning of power factor to users of electricity has always been difficult. While it is easy enough to make a consumer understand that by raising the power factor of his electrical installation he can save money, it is much less simple to get him to grasp the meaning of power factor and the reason for it being low. Various devices have been introduced with a view to demonstrating power factor mechanically. The latest is the Crompton Parkinson Power factor demonstrator, shown in the accompanying illustration. By turning a handle the continual reversal of the current and voltage is shown at a frequency which enables the observer to note changes without difficulty. To demonstrate unity power factor conditions the thumb screw to be seen in the lower part of the illustration is loosened and the pointer is set at unity by holding the dial stationary and by turning the hand wheel at the back of the instrument. After the pointer has been fixed by tightening the thumb screw, operation of the hand wheel gives indications of the voltage current and power at the top of the instrument. The current and voltage are shown to rise, fall, and reverse together and the power indicator ndicates maximum power.

If the pointer is set to, say, 0·6 power factor in the manner described, on turning the hand wheel the volts and ampères are shown by the upper pointers to reverse as before and to have the same maximum values, but the reversal of current does not follow the reversal of voltage, and the maximum value of the two quantities do not coincide; in other words, the current and voltage are out of phase by an angle corresponding to 0·6 power factor. The effect is shown by the pointer on the power scale, where it is indicated that the total power in the circuit is only 60 per cent. of what it was with the same current at unity power factor. The wattless current, which under these conditions circulates between the consumers' apparatus and the supply system, is shown by the oscillation of the pointers on the indicator marked wattless component. The lower pointer and dial form in effect a vector diagram.



POWER FACTOR DEMONSTRATOR

The effect of raising the power factor can be demonstrated by re-setting the lower pointer to, say, 0·9 lag on the power factor dial. On turning the hand wheel a certain amount of idle current will still be indicated, but the amount of power obtained from a given amount of current is shown to have increased to 90 per cent.

Electrical Engineering in 1933.

No. II.

(*Concluded from page* 11, *January 5th.*)

The Central Electricity Board.

BRITAINS "grid," intended to provide everyone with cheap electricity, was completed during 1933. On September 5th, the last of the 26,265 towers was erected at Fordingbridge, on the outskirts of the New Forest. By the end of November all the conductors had been strung and cables laid over the 4000 miles of the primary and secondary transmission system. From the time the contract was let for the erection of the first section of power network in the Central Scotland area, the undertaking has been completed in less than six years at a cost of about £27,500,000. Regional schemes completed in 1933 were those for South Scotland, South-East England, and South-West England, and South Wales. By the end of the year approximately 3500 miles of line had been brought into operation. The remainder will be put into service within the next few months. Since the beginning of last year the Board has been trading in two areas—Central Scotland and Mid East England. Grid tariffs were introduced in South-East England, East England, and North-West England on the first of this month. The Board then became engaged in trading on a commercial basis in areas aggregating 33,874 square miles, supporting a population of approximately 29 million people, or 65 per cent. of the entire population of England, Scotland, and Wales. As the result of commercial trading operations and experience of working arrangements under temporary supply agreements, many non-selected stations have been shut down. Many others are now used only for generation at times of peak load, and are put out of commission at week-ends, or during the summer months.

Work is progressing rapidly on the Galloway water power scheme. By operating a switch early in October, the chairman of the Board blasted the final portion of the rock in order to complete the 3½ miles of tunnel conveying the water from the new dam at Clatteringshaws (Fig. 1), to Glenlee, where one of the five selected hydro-electric stations of the South Scotland scheme will be situated. Work on the Clatteringshaws and Glenlochar dams was completed, and the erection of the power stations at Tongland and Glenlee is being pressed forward. It is hoped that some time during the present year the water power resources of Galloway will be harnessed for the "grid."

Control rooms for North-West England and North Wales, South-West England and South Wales, and South-East England and East England, were put into service. Six out of the seven "nerve centres" for the regional schemes are now operating, and only the North-East of England remains to be provided for. The Bristol control room (Fig. 2), for which the Automatic Electric Company, Ltd., was responsible, represents a departure from orthodox practice, in that for the first time in Britain it incorporates a miniature indicating panel. The Reyrolle control room for South-East and East England at Bankside, Southwark (Figs. 3 and 4) is the largest in the country, for it controls over 3,000,000 horse-power within an area of 12,266 square miles. By means of the indications received and recorded on the Centrovisory Control equipment in the control room, the interconnection of, and load sharing between fifty power stations, from Peterborough to the South Coast, is efficiently co-ordinated. These indications include the condition of circuit breakers ("open" or "closed"), the positions of transformer tappings, and various meter readings, such, for example, as Megawatts and Megavars (reactive MVA) of the 132 and 66 kV sub-stations and the more important lower voltage connections to the grid. A circuit diagram of the C.E.B. connections to these stations is depicted on the front of the centrovisory control board, whilst on the control desk there is a complete system diagram of all C.E.B. stations and connections for the area. Hand-operated contact-making circuit-breaker indicators form part of this diagram, the contacts of which are electrically interlocked with larger switch position indicators on the wall diagram Fig. 4, which also portrays the complete grid connections for the South-East England area.

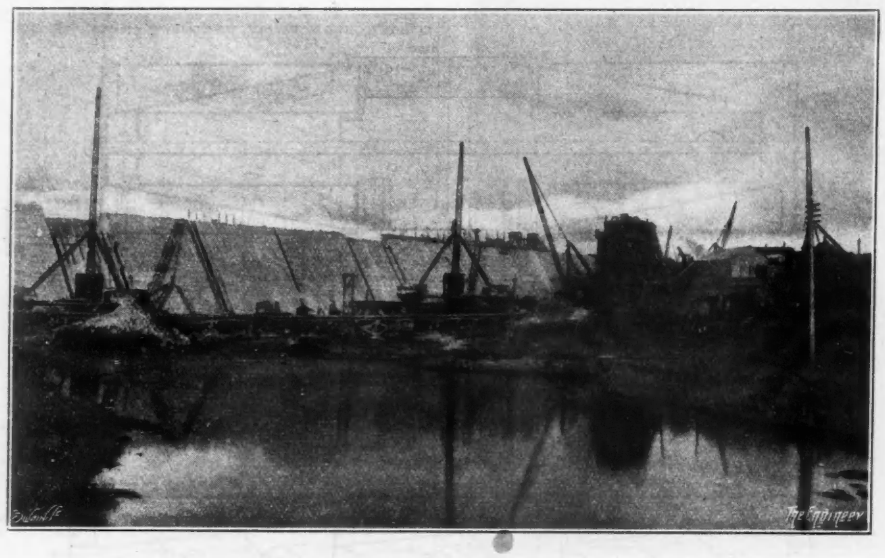


FIG. 1—THE CLATTERINGSHAWS DAM

Conversion to the standard frequency of 50 cycles per second was completed in Central Scotland, and attention was given to the Board's accelerated programme in the other areas, notably North-East England, Central England, and South-West England, and South Wales, where there has been considerable development on a non-standard basis. By the end of the year the aggregate horse-power of consumers' plant converted since the task was begun exceeded 750,000, the number of motors involved being nearly 50,000. Four circuit towers, as shown in Fig. 5, on the Nursling-Romsey line, forming part of the South-West England portion of the grid, are the first towers of the kind to be erected in this country.

Switchgear.

The reference made in the previous article to the new testing plant to be installed at the works of A. Reyrolle and Co., Ltd., shows what an important business main switchgear manufacture has become. Modern practice bears little or no resemblance to that of bygone days, when demand for electricity was relatively small. The need for much higher rupturing capacities has, as all electrical engineers know, given rise to the production of gear which is both massive and costly.

No attempt will be made to mention individually all the important switchgear contracts carried out during the past twelve months. Perhaps no section of the electrical industry was more active or is likely to remain more busy on industrial jobs during the next few years. Apart from switchgear directly associated with the "grid" itself, many equipments were made for direct supplies to large industrial concerns. Two Ferguson, Pailin installations, constructed to the order of the C.E.B. for the Ferguslie and Anchor mills of J. and P. Coats, Ltd., were among the most notable of the kind. The loads are 15,000 and 8000 kVA, respectively, and the supply is taken at 500 volts. In both cases the rupturing capacity is 80,000 kVA. The fact that this switchgear had to be capable of "making" and "breaking" under the worst short circuit conditions led the makers to undertake extensive researches relating to the design of low-voltage, heavy-rupturing, oil-circuit breakers.

By reason of the higher kVA available as the result of "grid" connections, this and other firms did much in the way of replacing existing breakers by new breakers. The rupturing capacity of many existing switchgear installations was also increased by Ferguson, Pailin by fitting a cross-jet explosion pot arc-control device, which has proved satisfactory in the smallest breakers up to those having a current-carrying capacity of 4000 ampères and one million kVA rupturing capacity. It must suffice to add to this brief and inadequate description of Ferguson Pailin activities that for the South-East England section of the "grid" a 33 kV, 500,000 rupturing capacity, completely oil-filled, outdoor-type metal-clad "single-switch" sub-station equipment was built. All the units are arranged for the future completion of the station as a "three-switch" station. The oil-circuit breakers are fitted with cross-jet explosion pots, and incorporate the inverted oil-filled type of self-aligning plug and socket members.

The design and manufacture of a new circuit breaker, with a single-break and a cross-jet explosion pot contact, which utilises the pressure produced in the oil by the arc to project a stream of oil at high velocity through the arc was the chief switchgear development of the Metropolitan-Vickers Electrical Company. Since the arc length, and, consequently, its duration, are shortened, one-arc control can be used per phase instead of two, and there is a considerable reduction in the space occupied by the gear. The illustration, Fig. 6, shows part of a cross-jet explosion pot single bus-bar switchboard, as described in our issue of August 18th. High-voltage outdoor switchgear of this type has been built, and by the application of the principle to standard breakers, the short-circuit rupturing capacity has been increased. A £297,000 contract for 66 kV. switchgear for the new Fulham Power Station was awarded to the company in October.

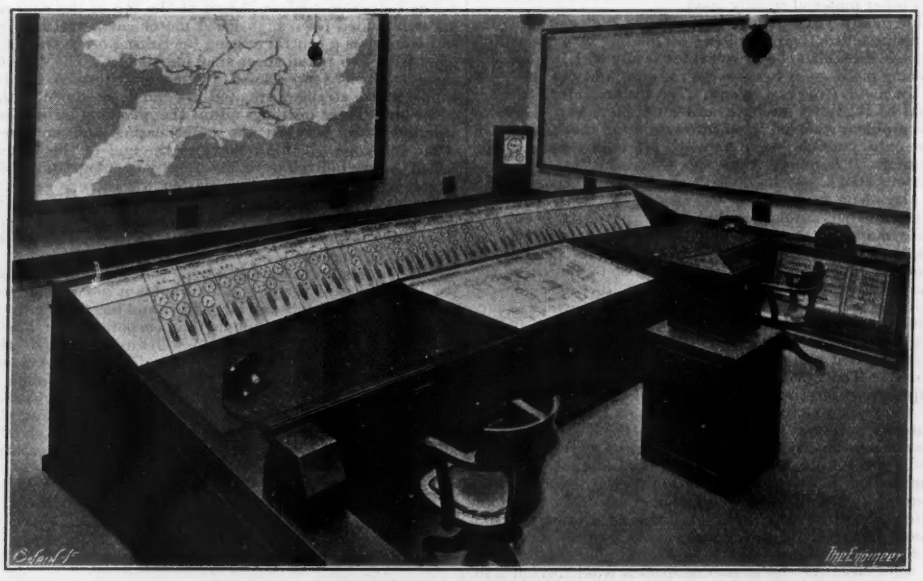


FIG. 2—THE BRISTOL CONTROL ROOM

Metro-Vick miniature station control boards, with illuminated mimic diagrams, were supplied to Hoylake and Cardiff, and a twenty-four-panel board of similar design is being made for the Bolton Corporation's new switch-house.

Several large metal-clad switchboards were supplied by the General Electric Company to various municipalities. Others are under construction. A new method of on-load bus-bar selection was incorporated

in the G.E.C. metal-clad gear. Several new designs of outdoor circuit breakers were developed, including one with a breaking capacity of 75,000 kVA, which can be supplied as a simple oil-circuit breaker, for pole mounting or floor fixing. It may also be equipped with an adapter chamber for bolting directly to power transformers, or may be used for ring main service, or as a switchboard with air-insulated bus-bars. A liquid immersed outdoor rewireable high voltage fuse, which can be wired by the user, was also developed.

Like those of several other firms, the British Thomson-Houston Company's account of 1933 switchgear activities cannot be dealt with in full. A new design of metal-clad switchgear was produced for the London Power Company's Carnaby-street substation. It comprises six 66 kV equipments, with oil-circuit breakers of 750,000 kVA rupturing capacity. In the main recognised metal-clad construction is followed, but phase isolation is adopted throughout, and the bus-bars have condenser-type paper insulation with an external metal sheath. Oil-immersed isolation switches serve for disconnecting the circuit breaker from the bus-bars and cable respectively. The breaker itself is of a new type. Another new product developed during the year is a single-break oil breaker, with the latest B.T.H. arc-control device, which, as tests have shown, enables a single break to be used for pressures of 22 kV and 33 kV, when breaking 500,000 and 750,000 kVA, and possibly more. Metal-clad, compound-filled, vertical, drop-down switchgear was produced for distribution work, and a corresponding range of air-insulated bus-bars, and thick oil-filled bus-bar and circuit chambers.

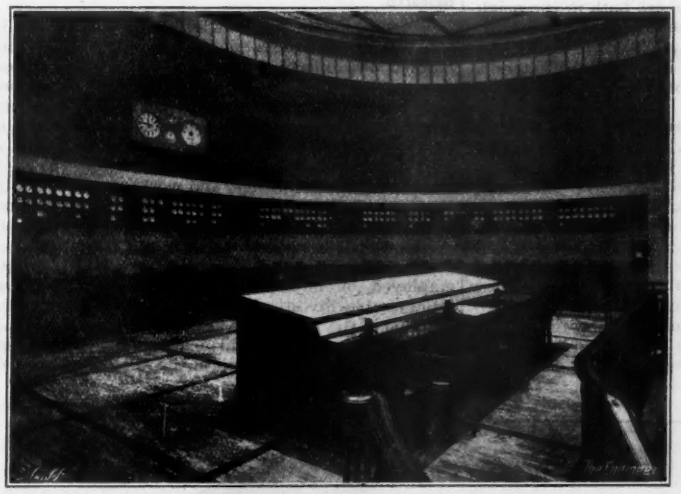


FIG. 3—THE BANKSIDE CONTROL ROOM

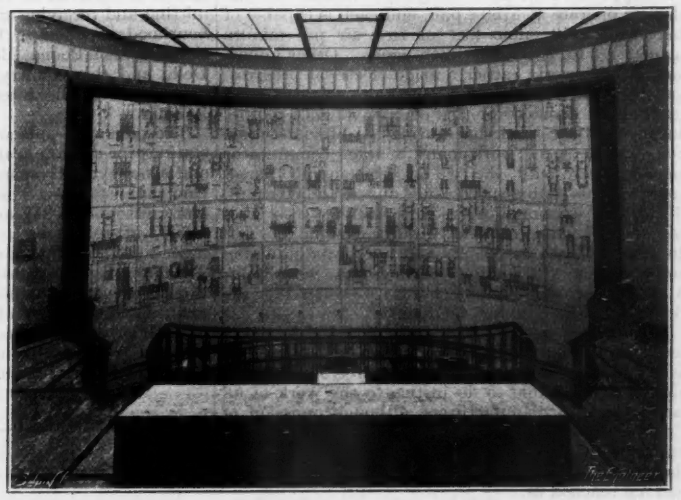


FIG. 4—WALL CIRCUIT DIAGRAM AT BANKSIDE

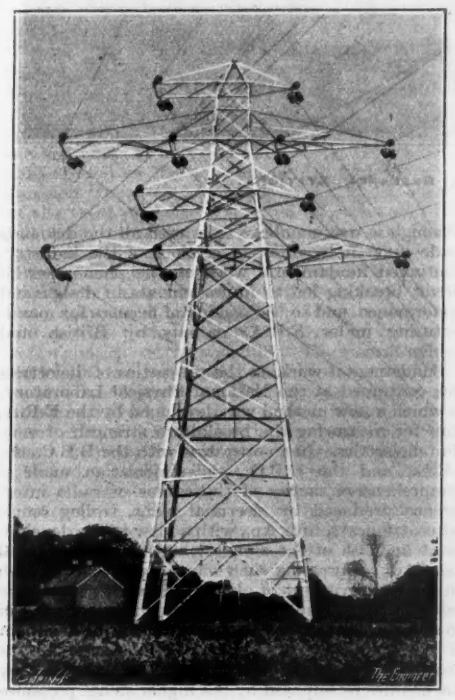


FIG. 5—FOUR-CIRCUIT TRANSMISSION TOWER

Electric Traction.

One of the most interesting electric traction developments was the rapidly increasing use of electric trolly omnibuses, equipments for which were made by most of the large electrical firms, such as the English Electric, G.E.C., Metropolitan-Vickers, and B.T.H. companies. A new B.T.H. traction motor for trolly vehicles has a single-turn armature winding. Even with the weakest field strength there is said to be an entire absence of sparking. It has been made as a compound-wound machine for regenerative operation with control gear giving seven weak field points, and as a regulated series field with six weak field points.

Much work was done by the Metropolitan-Vickers Electrical Company in connection with the re-designing of standard electric tramcar equipments for higher schedule speeds, and for regenerative control. With the growing need for increased speed the ordinary platform main current controller has become inadequate for the increased power needs. A Metro-Vick system has, therefore, been designed which confines the main current to the automatic heavy-duty apparatus, designed on the lines well established on electric railways, whilst a small master controller is operated by the driver.

The first order from the Southern Railway for modernising the electrical equipment of older trains was placed with the Metropolitan-Vickers Electrical Company, which is also still engaged on the Hungarian electrification scheme. The work being carried out by the English Electric Company for the Danish State Railway, 1500-volt D.C. electrification scheme, was described in our issue of April 20th. The total length of line then being dealt with was 26 kiloms., or 16 miles, and the orders being executed by the above named firm covers the complete electrical equipment of forty-two motor coaches and twenty-one trailer coaches.

On August 2nd, an official contract for the electrification of the main Warsaw railway junction was signed at the London offices of the English Electric Company. The contract provides for the supply of a large quantity of railway material, comprising locomotives, motor coaches, overhead line equipment, and sub-station plant for a 3000-volt D.C. system of electrification, valued at about 2 million pounds.

During March the penultimate section of the northern extension of the Piccadilly railway to Southgate and Enfield West was opened, thus carrying, by means of a line 2½ miles long, the Piccadilly Railway into a rural district with large areas available. The latest important railway electrification announcement during the year was to the effect that the Southern Railway had decided to extend its main line scheme from Wivelsfield and Brighton to Eastbourne and Hastings, and from Haywards Heath to Horsted Keynes at a cost of £1,750,000. The General Electric Company reports that important railway electrification work was completed for the L.M.S. and Metropolitan railways.

Industrial Electrical Equipment.

While orders for industrial electrification equipment were a long way short of plentiful, certain manufacturers are able to report on important work of this nature. The Metropolitan-Vickers Electrical Company is dealing with several orders for large winding engine equipments, as well as equipments for rolling mills, for installation both in this country and abroad. The General Electric Company is carrying out the electric driving of a very large calender in the Aylesford Paper Mills of Albert E. Reed and Co. It is also building several rolling mill motors for a new steel works in Monmouthshire, for the I.C.I. Metals, and for a steel works in Roumania. Interesting testing sets are under construction at Witton for the motor car industry, including twenty-four complete equipments for the Austin Motor Car Company for testing its 12 and 16 horse-

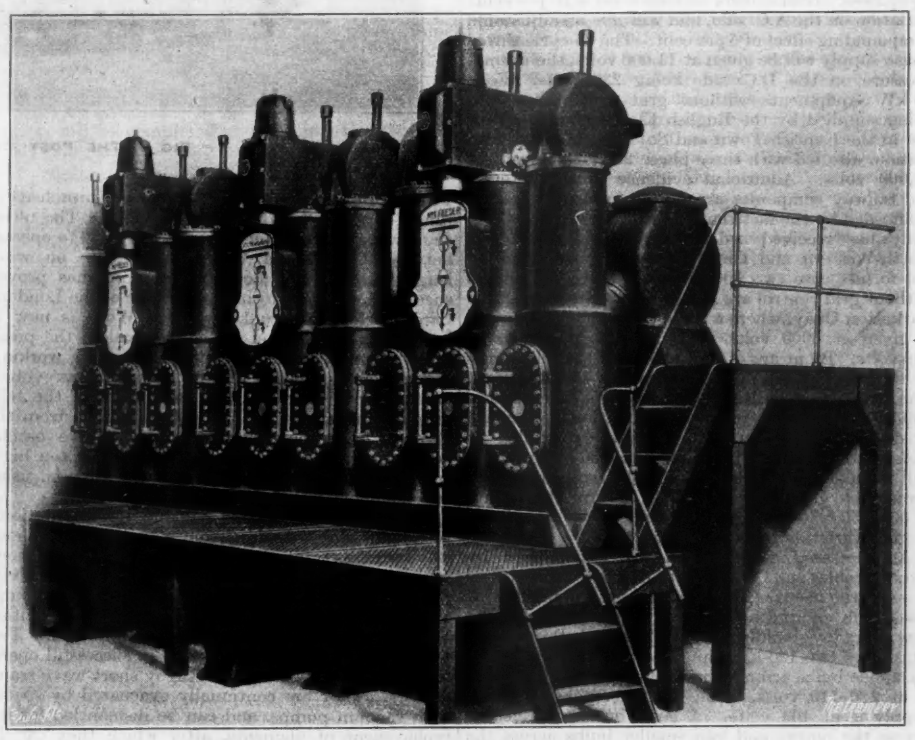


FIG. 6—PART OF NEW METRO-VICK SINGLE BUS-BAR SWITCHBOARD

power cars. A G.E.C. Fraser and Chalmers winder, driven by a direct coupled 1150 horse-power D.C. motor at a speed of 37·5 r.p.m., has just been completed for a gold mine in Southern India.

A new system was developed by the B.T.H. Company of pressure charging oil engines by means of high-frequency motor-driven blowers. An equipment consisting of eight blower units has been supplied to the Premier Gas Engine Company. As the engines are used for driving normal frequency alternators, a frequency changer is employed for driving the blower motors, which run at 4630 r.p.m. Each blower is rated at 2165 cubic feet of free air per minute at 0·95 lb. per square inch gauge. A similar equipment, consisting of four blowers and a frequency changer, was supplied to the same company. In this case the blowers operate at 5750 r.p.m. and each is capable of delivering 2210 cubic feet of free air per minute against 1·5 lb. per square inch gauge. Other important B.T.H. work, rather outside electrical progress, was the manufacture of compressors, blowers, and gears. The demand for this company's A.C. motors during 1933 exceeded that during the previous year. For variable speed work many Schrage commutator machines were built, the two largest being 400 horse-power motors with a speed range of zero to 500 r.p.m. B.T.H. A.C. sectional drives were installed in several paper mills and electric winders, including two duplicate Ward equipments and five large induction motor-driven winders for South Africa, were built. A D.C. rolling mill equipment was constructed for the Broken Hill Proprietary Company.

These notes are, of course, only intended to give a rough idea of industrial electrification activities. Bad as conditions were during the past twelve months, it has been impossible to do justice to the work of all large electrical manufacturers, although omission of English Electric activities in this and certain other sections of the article must be attributed to the fact that up to the time of writing the requisite information had not reached us.

Rectifiers.

The installation of glass bulb mercury arc rectifiers by the Hewittic Electric Company in sub-stations on the Liverpool-Southport and Manchester-Bury lines of the L.M.S. Railway marked a departure from orthodox practice. Although the use of these rectifiers on electric traction systems is far from new, metal-cased rectifiers have generally been employed for ordinary railway work, and it will be interesting to see if glass apparatus will continue to compete with the more modern form of power rectifier in this particular field. For the same railway the English Electric Company has just secured an order for three 200-kW glass bulb units, which will replace converting machines now used to give a supply to St. Pancras Station and Hotel. Each unit will consist of a six-phase rectifier with the necessary transformers and auxiliary equipment. Grid control will allow for a 10 per cent. variation on the A.C. side, and will give an adjustable compounding effect of 5 per cent. The 25-cycle three-phase supply will be given at 11,000 volts, the normal pressure on the D.C. side being 230 volts. Four 75-kW equipments without grid control are also being supplied by the English Electric Company for use in the Kentish Town and St. Pancras goods sub-station, also fed with three-phase 25-cycle current at 11,000 volts. Additional evidence of the interest the railway companies are taking in these rectifiers is afforded by the fact that the English Electric Company has received orders from the London and North-Western and Great Western companies. In the former case two 300-kW glass bulb equipments without grid control are being supplied for use at the Parkeston Quay, where a three-phase 50-cycle supply is given at 6000 volts, and the D.C. supply is at 440 volts. By means of contactor gear the bulbs may be switched in and out in accordance with the load. The Great Western Railway Company's order is for a 450-kW glass bulb rectifier installation to replace existing steam-driven D.C. generators installed at Fishguard Harbour. The three-phase 50-cycle supply will be taken at 11,000 volts and the rectifiers will be arranged to give a three-wire D.C. supply at a pressure of 500–250 volts. Manual grid control will provide for voltage variation from 220 to 250 volts.

An increased demand was also experienced by Bruce Peebles and Co., Ltd., for mercury arc rectifiers to meet the needs of industry and entertainment. A glass bulb equipment supplied by this firm for the new Faraday building of the General Post Office consists of two 120-kW units, each consisting of three six-anode bulbs arranged in cabins. The D.C. output is at 220–110 volts, while the three-phase 50-cycle supply is at 400 volts. A large bulb is connected across the outers and two smaller bulbs across the two sides of the D.C. system in the well-known way. Switching arrangements enable the bulbs across the outers to be cut out at light loads in order to secure high efficiency. A wave filter ensures that the amplitude of harmonics on the D.C. side are reduced to a value that precludes any possibility of interference with the telephone system. Grid control for the D.C. voltage variation has been provided when called for. To meet the demand for a small rectifier for battery charging and similar purposes the firm introduced a small rectifying unit, known as the "Rectigor," which comprises a mercury arc bulb instead of a thermionic valve.

Among the B.T.H. metal case rectifiers built during the year were units of 500, 1500, and 2000 kW capacity. Two rectifiers of outstanding interest, each rated at 800 kW and 20,000 volts D.C., were made for the British Broadcasting Corporation.

Post Office Wireless Work.

On May 1st, 1933, Sir Samuel Hoare, Secretary of State for India, inaugurated a wireless telephony service to India, operated by the British Post Office in conjunction with the Indian Radio Telegraph Company. Wave lengths of approximately 16 m. are used in each direction, and the service is operated from 0800–1300 G.M.T. daily. At the British end speech is transmitted from Rugby, while incoming speech is received at Baldock. In India the transmitting and receiving stations are both in the neighbourhood of Poona. The service provides connection between Poona, Bombay, Calcutta, Simla, and Delhi and this country. It is also to be extended over most of the international circuits served by London.

The policy of replacing spark equipments at coast stations for communication with ships was extended, and a new valve transmitter was installed at Land's End radio station. There are two I.C.W. telegraphy transmitters of 5-kW and 1-kW output respectively, a 300-watt telephony set, and direction-finding equipment to replace that formerly situated at the Lizard. The new telegraph transmitters are fitted with master-oscillator control by means of which the frequency is maintained well within the limits of ±0·1 per cent.

In the new Post Office engineering research station, referred to under the heading "Research" and illustrated in Fig. 7, special laboratories are devoted to wireless research work, for which a comprehensive range of equipment has been provided. The ultra-short wave radio circuit set up late in 1932 to operate between Cardiff and Weston-super-Mare on wave lengths in the neighbourhood of 5 m. has proved successful, and now forms part of one of the London–Cardiff telephone trunk circuits. Work is now in hand on a six-channel system to explore the possibility of multiple-channel ultra-short-wave working. A new voice-frequency telegraph system was evolved and put into operation for the control of the telegraph transmitters at the Leafield station from the Central Telegraph Office, London. Valve oscillators are used and provision is made for ten high-speed channels and two other wire circuits, using two telephone lines in underground cable.

To meet the increasing demand for international broadcast relays, the frequency response of the short-wave wireless transmitters at Rugby and of the short-wave receivers at Baldock was improved to facilitate music transmissions. Further uses for the demountable type of valve developed by the Metropolitan-Vickers Electrical Company were explored. Two 30-kW demountable valves were in successful operation during the year on the Rugby short-wave transmitters. They are continually evacuated by special high-vacuum pumps, and can be dismantled for the replacement of filaments, after which they can be brought into service again within a few hours. Extended tests on a 500-kW demountable valve on the long-wave Rugby telegraph transmitter showed promising results. Similarly a 500-kW sealed-off valve of the normal cooled anode type, manufactured by the General Electric Company, gave a fine performance.

A new system of speech transmission was brought into use on the long-wave Transatlantic telephony channel. The incoming speech is passed through a "compressor," so that the strong speech components are somewhat weakened and the weak components are strengthened. An "expandor" at the receiving end operates in the reverse manner, with the result that the mean level of the transmitted speech is increased and the resulting intelligibility is considerably improved when the "noise" is at such a level that it would otherwise cause the circuit to be uneconomical. During the summer months this extends the commercial time of operation, and it allows the transmitter to be worked with considerably reduced power during the winter months. The problem of reducing interference with broadcasting, as the result of the operation of electrical plant, was the subject of continued investigation by the Post Office Engineering Department, which is actively co-operating with the Committee set up by the Institution of Electrical Engineers to deal with the matter.

Research.

The opening by the Prime Minister of the Dollis Hill Post Office Research Station on October 23rd marked an important step in the field of electrical communication. A more elaborate or better equipped establishment devoted to the study of telegraph and telephone problems would probably be difficult to find. Besides the main research building shown in Fig. 7, there are other buildings which serve as additional laboratories, stores, and workshops. A lecture theatre, a training school, and a large constructional park on which men and youths are taught how to erect overhead lines and to undertake other outdoor work, are provided. The total number of people employed or in training often exceeds 600, and innumerable investigations essential to the efficient working of the Post Office are undertaken.

Notwithstanding the financial crisis the Electrical Research Association maintained all its researches, although it was unable to cope with all the demands made upon it by different sections of the industry. Continued fundamental work on the phenomena of circuit breaking led to improvements in design and performance, and to the seeking of licences for manufacturing under E.R.A. patents by British and foreign firms.

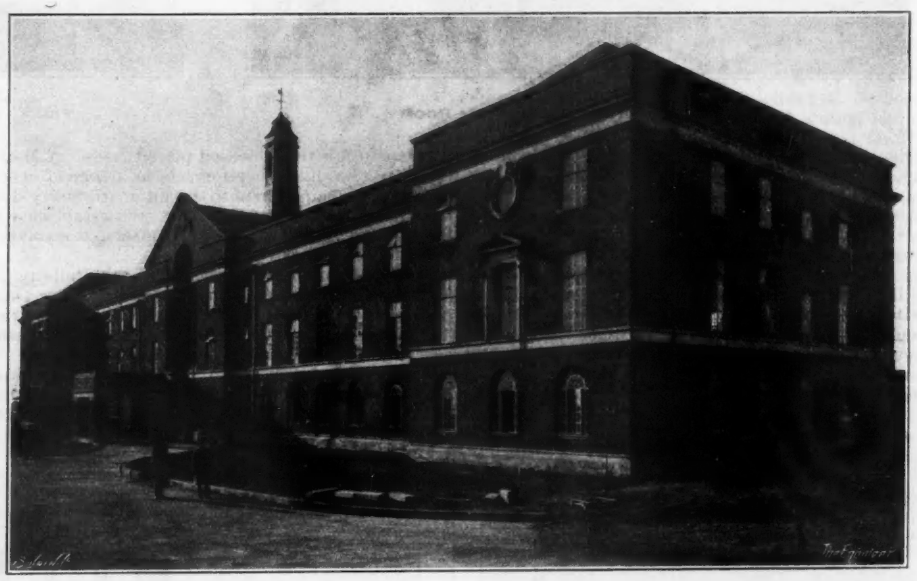


FIG. 7—THE POST OFFICE RESEARCH STATION

Fundamental work on the properties of dielectrics was continued at the National Physical Laboratory, in which a new method was developed by the E.R.A. staff for measuring the breakdown strength of very thin dielectrics. In co-operation with the B.B.C., the I.E.E., and the G.P.O., the Association made a comprehensive survey of the causes of radio interference produced by electrical plant, trolley omnibuses, tramcars, lifts, &c., with a view to the development and use of the simplest and most economical means of suppressing such interference. A research on the improvement of glass insulators to serve as a substitute for porcelain insulators, was initiated in co-operation with the Glass Technology Department of the Sheffield University. Work relating to the provision of special steels capable of withstanding the conditions imposed by the higher steam pressures and temperatures formed the subject of a special conference. Increased attention was paid to the requirements of railway engineers. Two reports dealing with earthing problems were issued during the year. The Association also reported to the British Standards Institution, the Institution of Electrical Engineers, and the British National Committee of the International Electrotechnical Commission on numerous problems referred to it.

Research work undertaken in G.E.C. research laboratories related, among other things, to Osira discharge lighting, catkin valves and wireless problems in general, and particularly to superheterodyne circuits, the production of small photo-electric cells, cold discharge tubes for Cleon and other electric signs, the design of fittings suitable for the Osira lamp, and the design of aviation lighting equipments.

The development of new products and improvements on existing products also claimed the attention of B.T.H. research engineers. Among the new products is the Mazda Mercra lamp, which is being used for street lighting at Ilford. Photo-electric investigations were carried out in connection with the application of B.T.H. cells to various appliances. Cathode ray low voltage oscillograph tubes were developed for different purposes, such as the study of wave form and of line scanning in connection with television. Special resins, new moulding powders and insulating materials were produced, and important investigations were undertaken on materials, &c., for refrigerator manufacture.

Broadcasting and Other Wireless Developments.

The tendency to increase the power of broadcasting stations in order to make them serve larger areas was exemplified by the British Broadcasting Corporation's decision to replace the Daventry National transmitter by a new 150 kilowatt, 1500 m. transmitter at Droitwich. For the most part broadcasting research work was confined to modulation problems, and improved systems of series modulation and the floating carrier system were developed by the Marconi Company. There was a marked tendency towards the more general use of super-heterodyne receivers, and the employment of multi-electrode valves for frequency changing in this connection rapidly increased. Much attention was given to automatic fading control devices. New types of valves, notably double diode triodes and double diode pentodes, were developed for that purpose. Tuning circuits for broadcasting receivers were made more selective and more efficient.

Television progress was made in two directions, (*a*) the transmission of a high-detail picture, with 150 lines or so, over short distances with waves in the neighbourhood of 6–7 m., and (*b*) the production of a 5ft. by 5ft. moderately low-detail picture with about 50 lines, which can be accommodated on a frequency band very little greater than that employed for normal high-class broadcast transmission. The two chief problems involved are intensity of light at the projection end, and synchronising difficulties, both of which are being grappled with by the Marconi Company. The development of the cathode ray system of television led to advances in the manufacture of cathode ray tubes. Cathode ray television pictures were produced in sizes up to 9in. by 9in. The advance of gas discharge tube technique as applied to television was marked. The study of the application of the Kerr effect to television projection led to notable advances in the construction of Kerr cells, both with solid and liquid dielectrics.

Micro-waves, or waves under 1 m. long, were used in several important wireless demonstrations in Italy and in England. Research work on these waves was devoted to increasing efficiency and to providing improved methods of modulation. The Barkhausen-Kurtz and Magnetron systems are being developed. Ultra short waves were applied to aircraft homing and landing systems. Much work was done on the development of directive aerial systems with a view to making them cheaper and more efficient. Knowledge of ionosphere conditions and wave propagation in general was increased largely as the result of the researches of Eckersley and Appleton. As mentioned under the headings of Research and Post Office wireless work, there was progress in the manufacture of anode-cooled transmitting valves, which are now made for much greater powers than in the past. Greater uniformity of characteristics and higher efficiencies have been secured in all types of valves. The need for precise wavelength adjustment and quantitative measurement of the performance of wireless apparatus led to increased accuracy in the design of measuring instruments, such as frequency meters, modulation meters, and signal strength measuring apparatus.

Water Supply & Sanitary Engineering in 1933

No. II.

(*Concluded from page 26, January 5th.*)

Liverpool.

NEW works carried out during the year 1933 were chiefly in connection with the supply of water from Lake Vyrnwy. The construction of large open strainers at the outlet of the new Aber tunnel was commenced in 1932, and is now complete. The strainers and the tunnel form part of an alternative draw-off from Lake Vyrnwy, but no work has as yet been done on the connecting link between the lake and the tunnel.

The development of the Vyrnwy aqueduct has been carried out by stages during the last six years. The method adopted up to the present has been to select that section of the aqueduct which had the lowest carrying capacity, and, on that section, to lay a length of the third pipe line connected at each end to the two existing mains. The section which now has the smallest delivery is that between Oswestry and Malpas, and it is proposed to increase the carrying capacity of this section by different means. The water drawn from Lake Vyrnwy is filtered at Oswestry, and at this place a steep step-down is introduced in the gradient of the aqueduct. The Hirnant-Morda section of the aqueduct, which conveys unfiltered water from Vyrnwy to Oswestry, terminates in a storage reservoir lying close to and 117ft. above the filter beds. Briefly, under the new scheme, it is proposed to pass the high-pressure water feeding the filter beds through turbines, the exhaust water passing on to the filter beds as at present. The turbines will drive pumps, which will pick up filtered water as it leaves the filters, and force it at an increased pressure into the existing mains leaving Oswestry, and thus increase the delivery of the next section of the aqueduct. The total head available between the Llanforda reservoir and the inlet to the highest filter beds is 117·5ft., and by laying additional mains for the short distance between these two points, so as to reduce losses due to friction, it will ultimately be possible to develop about 1000 horse-power. As it is intended that when the aqueduct is fully developed the whole of the water power available at Oswestry shall be utilised to increase the gravitational rate of flow through the Oswestry–Malpas section, each of the successive installations of the boosting plant will be so proportioned and arranged as to make use of the energy in a given quantity of unfiltered water to boost an equal quantity of filtered water.

It is proposed to make one slight departure from this general principle, by allocating a quantity of 2 m.g.d.—*i.e.*, the supply to one filter bed—to drive a small auxiliary turbine coupled to a dynamo for the generation of electrical energy. The boosting plant will be installed in three stages, and similar sets of turbines, combined with pumps being added, as and when additional quantities of water are required to be sent from Oswestry. The estimated cost of carrying out the first stage of the booster scheme is £18,000. This includes one set of combined turbine and pump, all mains, pressure sustaining and other valves, the electric generating plant, Venturi meters, and pressure recorders, together with the provision of a suitable building of sufficient size to house three sets of turbines and pumps with auxiliary plant and instruments. The first stage of development of the boosting scheme is estimated to increase the carrying capacity of the two existing mains on the Oswestry–Malpas section of the aqueduct by 3¼ m.g.d. to a total of 31 m.g.d. The pump house has been erected and the first turbine and pump, together with the turbo-generator, installed. It is expected that the pipe laying will be completed and the plant set to work early this year.

Louth.

Considerable progress was made in carrying out a scheme which was prepared for the borough of Louth, Lincolnshire, and which comprises the construction of supplementary sewage purification plant to be used in conjunction with existing detritus pits and sedimentation tanks.

It was designed by Messrs. Dodd and Watson, of Westminster, and consists principally of three circular biological filters, two shallow horizontal flow humus tanks, and new sludge lagoons.

The filters are each 110ft. in diameter and will be fitted with rotary distributors. The humus tanks are each 35ft. 3in. long by 60ft. wide. The walls and floors of these new filters and tanks will be constructed throughout of reinforced concrete.

Owing to the unsatisfactory nature of the ground, it was deemed advisable to support the new works entirely upon reinforced concrete piles formed *in situ*, and the structures were designed accordingly. The total number of piles is 390. All the piles were formed by the "Vibro" process, and the driving tube was in each case sunk until a satisfactory set was obtained. The average length of the piles under the filters is 41ft. and of the piles under the humus tanks 24ft.

The Hadsphaltic Construction Company, Ltd., is the general contractor for the scheme, and the "Vibro" piling was carried out under licence by John Gill (Contractors), Ltd. The total cost of the work will be about £14,400.

Manchester.

Wythenshawe Main Drainage.—Work is in progress on the construction of sewers in Brooklands-road, Baguley, varying in size from 12in. to 36in. diameter, to intercept the sewage which at present discharges into an existing culvert and into the river Mersey. The work includes a storm water overflow and pumping plant to raise six times the dry-weather flow into the sewers of an adjoining district.

Work was begun in October on the construction of an outfall sewer connecting the sewage works of the Cheadle and Gatley Urban District Council with the Wythenshawe main drainage scheme. The sewer varies in size between 3ft. and 4ft. 6in. diameter, and about 750 yards of the 3ft. diameter, which is being constructed with concrete tubes 8ft. long, is carried above the existing ground level on reinforced concrete piles.

Sheffield.

Ewden Valley Scheme.—The construction of the Broomhead reservoir has been attended with many difficulties, arising out of the adverse underground conditions revealed during the progress and towards the completion of the works. In 1924 heavy remedial works had to be undertaken owing to an extensive slip in the ground forming a hillside, immediately to the north of and adjacent to the embankment. This slip has been generally spoken of as the Waldershelf Slip. Impounding of the water in the reservoir was first begun in May, 1928, when shortly afterwards it was found that concurrently with the raising of the level of the water certain runs of water in the vicinity of the embankment increased in flow, and new ones appeared, indicating that water was escaping from the reservoir. It was decided as a remedial measure to execute cementation work by the sinking of bore-holes and thereby injecting cement into the underground fissures. In April, 1930, there was a marked movement of the ground which formed part of the former Waldershelf Slip. The movement extended downwards to about 15ft. below the overflow level of the reservoir, and threatened certain permanent works. With the object of permanently stabilising this, the upper part of the slipped material is now being removed by excavating about 150,000 cubic yards of that material, depositing part of the spoil as permanent filling on the flat below the downstream toe of the embankment, and the remainder as filling in the groin between the downstream side of the embankment and the southern hillside, to form a buttress to an old slip near that corner. Deep rubble wall drains are also being constructed in the slope which will be left after the excavation, and from the bottom of the deep trenches for these drains, drainage headings have been driven into the hill for the purpose of draining off water from a large mass of rock situated to the north of the excavation. Extensive catch-water drains have been constructed to the north and around the outer margins of the slip for the purpose of preventing the access of excessive surface water thereto.

The works now being executed formed the subject of a Ministry of Health inquiry in Sheffield in December, 1931. Up to the present more than fifty bore-holes have been sunk for the purpose of cementation, the aggregate number of feet bored being in excess of 11,000; and more than 7500 tons of cement have been injected by this means. Six underground water pressure ascertaining and relief bore-holes have also been sunk.

The result of these remedial works up to date is that the uncontrollable runs of water below the embankment, other than surface water, have been reduced from an aggregate of over 2½ million gallons per day to less than 1 million gallons per day, with the water in the reservoir at a comparable level, viz., 20ft. below overflow level. These remaining runs of water are in safe channels.

As a result of the remedial works in connection with the Waldershelf Slip, there has been no movement of that slip during the last twelve months, whereas previously nearly every monthly record showed some movement.

Southend-on-Sea.

During the past year the Corporation brought into use the new sewage purification works, for which it obtained authority from Parliament in 1926. The longest task involved was the construction of the sea outfall, 60in. in diameter and laid across the foreshore to a point near the Knock Buoy, a mile and a-half from the beach. This took nearly five years to construct. The three miles of tunnelled sewer between the Prittlewell sewage purification works and the sewage works themselves are now in full operation. Of the many features at the sewage works, the most striking are the three sedimentation tanks, each 100ft. square and mechanically sludged. Messrs. Dodd and Watson, of Westminster, were the engineers, and they constructed these new works in a gravel pit 30ft. below the level of the old works which are now superseded. The cost of all the new work was £260,000.

Swansea.

Very considerable progress was made during the year with the main trunk sewer which is being constructed in two contracts. The work comprises about 11½ miles of sewer, varying between 2ft. and 5ft. 6in. diameter circular and 7ft. 9in. by 5ft. 2in. egg-shaped, together with four parallel storage tanks, each 16ft. 6in. wide by 10ft. high by 2000ft. long, and twin 5ft. diameter cast iron sea outfall pipes. The total lengths of sewer completed to date amount to 4½ miles. On the remaining portions, of which a considerable part is in tunnel, much of the heading work has been driven and lined with cast iron segments, including a

length of over 2 miles in the centre of the town. The excavation for the storage tanks has been completed, and approximately one-third of the sea outfall has been laid.

The final section of the Fforestfach and Warnarlwydd sewerage scheme, which includes disposal works at Gowerton and an outfall to the Afon Lliw, was put in hand during the year.

Wolverhampton.

The recently completed sewerage works now replace the old tank and land treatment and the existing bio-aeration plant has been incorporated therein so that it is now possible to purify completely the whole of the normal dry weather flow to the works and to treat all storm water partially.

After the recent inauguration ceremony prepared by the Chairman of the Sewerage Committee, the guests, totalling about 150 in number, were shown all over the works, when it was seen that the new treatment incorporates the old bio-aeration plant in such a way that the sequence of operations is—screening, grit removal by mechanical means, primary sedimentation and mechanical sludging and secondary sedimentation combined with volume balancing, followed by flocculation in bio-aeration channels and distribution over 10 acres of new bacteria beds 7ft. 6in. deep. The bio-aeration plant and the bacteria beds may be worked either in parallel or in series to obtain the best results. Digestion of sludge forms another important feature of the new works, and there are new humus tanks, storm water tanks and two new sludge pumping stations. Messrs. Dodd and Watson, of Westminster, were the engineers and have completed the new works at a cost of about £240,000.

France.

Sanitary Engineering.—Hardly anything was done during the year with the Paris sewerage schemes, which depend upon a final decision as to whether it is better to proceed with an extension of the activated sludge or other processes or whether the whole problem should be solved by carrying sewage to new farms beyond those at Achères. Experiments with many systems have not led to definite conclusions, except that their cost may be very heavy when the time comes to deal with the increasing volume of sewage, now that Paris is absorbing so many of the suburbs, and the municipal sanitary engineers are strongly in favour of sewage farms, which they regard as offering the only practical means of solving the difficulty. Three or four years ago this was to have been done by a vast scheme for collecting the sewage in syphons and sending it by a main with a very slight gradient for a distance of about 12 miles to the new farms which the Municipal Council had acquired on the banks of the Seine beyond Achères. There were pumping difficulties which compromised the success of this scheme. It was, moreover, strongly opposed on all sides, and it was sought to obtain parliamentary injunction against the creation of new sewage farms. The Paris municipal engineers have attempted to override this opposition by pointing to the success of the Achères farm, and giving reasons to show that the new farms would not be prejudicial to public health and would not offer local inconvenience. The problem therefore remains very much where it was a year ago. On the Riviera there was also trouble, for Nice and other towns sought powers to discharge sewage into the Mediterranean under conditions which, it was affirmed, would ensure the sewage being swept away from the shore, but the authorities declared that the sewage must be treated on land, and only clear water diverted into the sea. Here, again, municipal schemes for sewage treatment are held up on account of the cost. With regard to household refuse disposal, a noteworthy feature was the final acceptance of incineration following upon improvements to furnaces for combustion at high temperatures, the production of electricity which is partly used in some towns to recharge lorry batteries for the collection of refuse, and the elimination of sulphur and other constituents that rendered slag bricks unsuitable for building. The installation at Lyons was the first really efficient and economical incineration plant in this country, and at the beginning of the year a combined refuse incinerating and coal and coke mixture burning steam plant was started at Bordeaux, with results that are declared to be highly encouraging. The gases from the refuse furnaces pass into the combustion space of Babcock and Wilcox furnaces for steam raising. Improvements in the way of higher combustion temperatures have also been carried out to incineration plants in Paris.

Water Supply.—The plans for providing adequate supplies to the 38,000 communes throughout the country are dependent on funds voted by Parliament, and during the past year the work was seriously impeded by financial difficulties which compelled the State to reduce monetary grants for that purpose. About a third of the communes have profited from State aid to procure supplies of water, and the work remaining to be done is so vast and urgent that proposals are made to carry it out by means of a national organisation. It will, at all events, be brought within the scope of the national programme of public works. In Paris little more has been done in the way of filtering and treating river water, the volume of which is sufficient for present requirements, and having no new sources of spring water to rely upon, the Municipal Council looks for future supplies to the Vals de Loire. Tenders have been obtained for the construction of an aqueduct which will bring a million cubic metres of water a day to Paris from the apparently inexhaustible supplies underneath the fine deep sand of the Vals de Loire, and the final plans will be settled after examination of the proposals submitted. Their value as a means of supplementing the water supply, if necessary, was also a factor in determining the construction of flood reservoirs on the upper reaches of the Seine. One reservoir was filled during the year, and a second barrage is on the point of completion. These supplies are provided mainly in view of the increasingly heavy suburban requirements, and at Aulnay-sous-Bois an artesian well was sunk to a depth of 880 yards with the object of obtaining 5000 cubic metres of water a day for the north-eastern suburbs. In various parts of the country work has been carried out, notably at Lille by means of wells, and along the Riviera there are several schemes for bringing water to Grasse and other towns from Alpine lakes. At Nice wells are being sunk along the valley of the Var, and a pumping station is being erected for raising water to a reservoir on a hill behind the town, mainly for supplying the suburbs. Nancy has adopted the ozone process for the treatment of river water. Much has been done during the year to improve the water supply, but no works of importance were actually put in hand.

Hong Kong.

Shing Mun Valley Waterworks.—When reporting the position of this work twelve months ago, the main dam to be constructed was described as a concrete arch. Since then the results of intensive exploratory work on the site have necessitated a new location, somewhat downstream of that provisionally adopted, and a change of type. The design now adopted consists essentially of a reinforced concrete diaphragm wall in continuation of the concrete in the cut-off trench. This diaphragm rests against the battered face of a mass concrete retaining wall, and downstream of this is rock fill.

The height of the dam above stream bed is 275ft. The excavation of the cut-off trench and for the foundations of the concrete retaining wall are proceeding rapidly, and a sub-contract has been let for the concrete-lined river diversion tunnel.

Contracts for the manufacture in Britain of the steel and cast iron pipes and valves have been let, and substantially the whole of the plant has been made in this country.

The work is being carried out for the Government of Hong Kong by direct administration to the designs and under the supervision of Sir Alex. Binnie, Son and Deacon, the resident engineer being Mr. G. B. Gifford Hull, M. Inst. C.E.

Egypt.

In our issue of June 2nd, we described and illustrated the work that is being carried out under the direction of Sir Murdoch MacDonald and Partners on the second heightening of the Aswan Dam. An engraving in one of the Supplements to the issue of January 5th shows this work in progress. It is expected that it will be completed in February.

South African Engineering Notes.

(By our South African Correspondent.)

Industrial Activities.

AN important forward step in connection with the starting of the Pretoria Steel Works was taken on Monday, December 4th, when the first portion of the plant—the coke ovens—was fired. The next section of the plant to be put into operation will be the power station, while the blast-furnace, the most imposing part of the plant, will be lighted towards the end of January. The Newcastle ironworks is to be closed owing to the opening of the Government works at Pretoria, and there seems to be no hope of the company doing anything further at Newcastle. The operations carried on there have been almost entirely confined to making pig iron, the only blast-furnace in the country having been erected there. It is contended by Mr. Nel, M.P. for Newcastle, that the town has been hardly dealt with by the works being closed down, as it has been demonstrated that pig iron is produced there at less than it was estimated it could be produced at Pretoria. The fact seems to be that the Government has determined to make Pretoria the great centre for the production of pig iron and also of iron and steel, thus compelling the concentration there of the various works which will be required for the production of subsidiary products. The rapid development of railway electrification, and the demand for electricity for industrial and other purposes, is steadily transforming the Natal coal industry, and important changes are likely to take place shortly. As the result of railway electrification the coal consumption of locomotives has dropped by 16,000 tons a month since 1926. Industry after industry is turning to electricity. The output figures for the coal industry of Natal fell from 5,000,000 tons in 1926 to less than 3,000,000 tons last year. The Provincial Council of the Transvaal has agreed to the Johannesburg City Council raising £280,000 for its electric power scheme. A Union tender board is to be established by the Government to deal with the purchase of Government and railway supplies with the aim of getting more of the requirements supplied by Union industrial concerns, thus improving the demand for white labour. The board will consist of railway and Union officials and two representatives nominated by the Associated Chambers of Commerce and industries. Mr. W. B. Dawson, superintendent of rolling stock of the South African Railways, has accepted the position of chief traffic manager of the Rhodesia Railways from January 1st. Mr. R. G. Forbes, superintendent operating in Durban, takes Mr. Dawson's place on the S.A.R.

Remodelling Electric Systems.

Now that money is plentiful and cheap, a large number of municipal electrical enterprises are being modernised, remodelled, and extended, while towns which have not so far gone in for electrical schemes are having reports, plans, and estimates prepared, with a view to ordering installations. Almost universally town electrical engineers are recommending their Councils to convert from direct current, now largely in use, to alternating, with the result that this work is being entered upon in a number of places. All the big towns have already adopted the hire-purchase system in regard to cooking stoves, water heaters, heaters, irons, and other domestic electrical appliances, and it has been largely taken advantage of, much to the benefit of the sales of electricity. Durban City is foremost in these activities, with the result that 1115 stoves were installed in 1932–33, making a total of 10,882 now in use; only 322 water heaters were installed, a considerable fall, one of the causes of which is said to be that consumers prefer to buy refrigerators rather than water heaters, no less than 1046 of the former having been installed during the year, making a total of 3114. In Cape Town, during the three years the system has been in operation, local electrical appliances dealers have benefited to the extent of £205,261 and electrical wiring contractors have benefited to the extent of £58,010. In the last nine months—during which the repayment period has been made twenty-four months instead of twelve months, as before—cooking ranges have been installed at the rate of 210 per month, compared with 135 previously. It has been found that the cost of running a home by electricity in Cape Town averages about £1 4s. per month for a six-roomed house. Among the municipalities about to improve and remodel its electrical system is Krugersdorp, which is going to spend £32,000 for that purpose. A number of the smaller municipalities intend to follow the cities and adopt the deferred payment system for domestic electrical appliances and their installation.

Alcohol from Molasses.

Criticisms of the maize-alcohol plan, mentioned in my last letter, are not wanting. The critics urge that the scheme will only result in fixing the price of maize for years to come at less than the cost of production. Also, they say, according to the particulars given, that a capital of £235,000 will be required to deal with 190,000 bags of maize annually and 5000 tons of barley; that the wage bill will be £30,000 a year; that 15,000 tons of coal will be required; and that it would require £125,000 for an output of 1,400,000 gallons of alcohol, or 1s. 9d. per gallon, as against the present price of petrol of 11d. to 1s. 2d. per gallon. Dr. Arnstein, in his reply, stated that the by-products obtainable from maize, in addition to power alcohol, were glycerine, ether, dry ice, yeast, and maize oil, most of which were at present imported. He also enumerated hundreds of uses to which alcohol was put in the industrial sphere. Besides the main product, there would be good markets for all the by-products, which in themselves would justify the establishment of the plant.

Union Steel Corporation Expansion.

Two new three-phase Heroult furnaces have recently been erected at the wire works of the Union Steel Corporation at Vereeniging for the production of hollow drill steel, but they will also produce tool and alloy steels of the type required by local industry. Between them these furnaces will have an annual capacity of close on 5000 tons of liquid steel, giving a marketable yield in the region of 3000 tons. This forward step has been prompted by the gratifying results obtained from "U.S.C.O." hollow drill steel in the mines of the Witwatersrand. Production of the material at Vereeniging was started early last year, but in the initial stage of development output was limited to about 900 tons per annum owing to the prudent desire to prove both process and product before embarking on heavy capital expenditure. Now that the new furnaces and associated equipment are in commission all stages of production are grouped under one roof in a spacious and lofty well-lit shop, giving as fine an ensemble for the purpose as can perhaps be found anywhere in the world. It is expected that the co-operation possible between the mine official and a hollow drill steel producer, less than 50 miles away, will be found distinctly valuable to the mining industry, and there is every reason to expect that this new branch of the steel industry of the Union will be encouraged and supported by the mining houses. A wide variety of sections is already available, including squares, rounds, hexagons, and octagons in various sizes. The "U.S.C.O." speciality is a hollow drill steel with a stainless iron liner, not loose, as hitherto, but forming an integral part of the steel. This result is achieved by casting the steel round a stainless iron tube in the mould.

Victoria Falls Power Company.

Mr. A. F. Hadley was able to give a very gratifying account of the continued progress of the business of the Victoria Falls and Transvaal Power Company, Ltd., at its recent meeting. Revenue from light and power supply advanced by £80,288 to £1,266,865 last year and the demand has reached 281,000 kW. Various new developments as a result of South Africa going off gold are in prospect, and designs are in preparation for further extensions to the plant, which will probably include a new power station. The company already gives supply from five stations and the total installed capacity is 390,000 kW. Units sold advanced by 7¼ per cent. All the power is supplied to the mining industry excepting 3 or 4 per cent. which is used by other consumers, whose need also arises from business created by the mines. These non-mining consumers comprise all the municipalities along the reef, except Johannesburg, which is likely to be connected to the system shortly for standby purposes, and a number of industrial companies.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

British Steel Prices.

The advance in the prices of raw materials has led to reports of an impending increase in the quotations of controlled descriptions of British steel, but the position in this respect is by no means clear. There is no doubt that a section of the industry would like to see prices advanced from the levels which have ruled since December, 1929, but it is questionable whether the industry as a whole would support such a proposal, as although some justification could be found in the recent increases in costs, it might not be altogether politic in view of the proposed reorganisation of the industry. The reports of an impending increase which have found their way into print lately have had little foundation in fact, since it can be definitely stated that the various associations have not yet seriously considered the question. There should be a meeting of the steel makers, including the Scottish manufacturers, this month, but the date has not been fixed. It may be that, as the reorganisation scheme provides for the central control of the whole of the steelmaking industry, including the lighter branches of the trade, it will be decided to leave the question of prices alone until the scheme has been either accepted or rejected. One thing, however, is certain—that prices will not be reduced.

The Pig Iron Market.

Although the market was active right up to the Christmas holidays, business since has been rather slow in developing. This is principally because the foundries are well covered for some time ahead, and so far as Cleveland iron is concerned, there is difficulty in obtaining near delivery. It is expected that the position will be made easier before the end of the month by the relighting of a furnace at Skinningrove, which will produce foundry iron. This will only partially relieve the stringency in the market, but some consumers seem to be in the position of being able to wait and to be willing to take their chance of prices being advanced. Expectations of higher quotations had much to do with the rush of consumers to cover themselves last month, and even if these anticipations were not realised the prospects of an upward movement do not appear to have lessened. On the other hand, large importations of scrap from abroad have checked the price advance in that market, and the ironmasters may hesitate to increase the disparity between the present prices of foundry iron and scrap, as the wider the margin in favour of the former the greater the proportion of scrap likely to be used. One effect of the scarcity of Cleveland iron has been the increased use of Midland brands by the Scottish foundries, as well as by users in the Cleveland district. This is helping to reduce the stocks in the Midland makers' yards, which are said to be fairly heavy at some works. The demand from the Midland light castings foundries is reviving, and should soon be as strong as before the holidays, and, in addition, there are indications that the requirements of the heavy engineering industries will increase. The situation in the hematite pig iron market holds out good prospects for the next few months. The production on the North-East Coast is less than the make, and the unsold stocks in the hands of the makers are said to be insignificant. It is likely that fresh furnaces will be put into blast at Redcar shortly. Although the local demand is heavy, a considerable tonnage is going to Sheffield and the Midlands. On the North-West Coast also the stocks which weighed upon the market for so long have been largely liquidated, and the demand from the Midlands and South Wales is reaching the levels ruling before Christmas. It is expected that a fresh furnace will be lighted in Cumberland and another in the Furness area during the next few weeks.

Semi-Finished Steel.

Trading in this department of the market has been light since the holidays, but there has been no relaxation of the pressure upon the works for delivery. Some of the Midland and Yorkshire re-rollers complain that the suppliers are behindhand in deliveries. The producers of semis, however, contend that there are comparatively few cases of delays, and that they are neither sufficiently numerous nor protracted to give occasion for general complaint. Some consumers profess themselves anxious regarding the prospects of an advance in prices in the near future. They point out that stringent conditions have ruled in the market since the middle of November, and that prices since then have advanced to a minimum of £5 10s. for billets and £5 5s. to £5 7s. 6d. delivered for sheet bars, although the official minimum price is £5 5s. for 500-ton lots. If the demand continues at its present strength they fear further increases. In some cases this has been guarded against by consumers entering into arrangements with producing works over a period, and it is also suggested that if the steel makers' reorganisation scheme is put into operation consumers will be able to ventilate grievances through their associations. In spite of such arguments, however, there are some manufacturers who make no secret of their desire to press for the introduction of a plan by which they could obtain a "drawback" of a proportion of the duty paid upon imported semis used in the production of material for export. The suggestion does not seem to have obtained much support, perhaps because of the comparatively small tonnages of foreign material which have been offered in the British market of late. The demand for billets, however, has enabled the Continental makers to raise their prices, inclusive of delivery charges and duty, to a parity with the British works quotations, and still retain a portion of their British market. The quantities sold, however, are small, the imports running to between 20,000 and 25,000 tons per month. There is another factor in the situation which may alter this position. The principal reason for the limited offerings of foreign semis has been the curtailment of production by the European Steel Cartel, but it is now expected on the Continent that the quotas will be increased, and if this is done more material may be available for the British market. In that event it is possible that the Continental makers will not maintain their prices with the firmness they have shown during the past month or two.

The North-East Coast and Yorkshire.

Business in the finished steel section of the market revived after the holiday break more quickly than in other departments, and this is an encouraging sign, since the demand was rather quiet in the closing weeks of last year. The market is certainly optimistic and looks forward to a progressive improvement during the first three months of the year. On the North-East Coast the orders for ships and railway material placed towards the end of December have created a feeling of confidence. Work for the railways is already in hand, and specifications arising from the contracts for ships are beginning to make their appearance. The constructional engineering shops are not as a general rule so busy as they were a few weeks ago, but it is anticipated that more active conditions will develop before the end of the month. The flow of orders of a miscellaneous character tends to increase, and this points to a gradual improvement in the condition of the smaller steel consuming industries. Export business is slow, and is likely to remain so whilst the barriers created by exchange controls exist. The Yorkshire iron and steel works have commenced the year under satisfactory conditions, and in the expectation that their order books will be improved shortly by fresh contracts from the railway companies. The mills producing sections are well employed, particularly those making small sizes. There is also a strong demand for stainless steel; whilst the works manufacturing strip are amongst the busiest in the industry. The request for small bars also is maintained, although several running contracts have been completed and have not been renewed. Business in crucible steel has become active.

Scotland and the North.

Most of the Scottish works have resumed work following the New Year holidays, but some departments did not restart until late in the week, as necessary repairs to plant had to be carried out. Busy conditions are likely to develop almost at once, as the works have good order books and specifications for the steel required for the new ships ordered from Clyde shipyards in November and December will soon begin to reach the makers. The prospects of the engineering industry are better than for a long time, and several establishments have important contracts in hand. The local tube works are also busy, although export business has not been satisfactory during the past few months. The overseas demand for sheets also has been poor, but home requirements keep the mills fairly busy. The re-rollers are not altogether happy at the moment, as the advance in the cost of semis has caused them some anxiety, but apparently they hope to reach an agreement with the steel works supplying this material, which will improve their position. The Lancashire steel market has made a somewhat slow recovery since the holidays, but an undertone of confidence has prevailed, and the industry is as busy as it was in mid-December. This week there has been a noticeable increase in inquiry of a general character, in which the export side of the market shared. This applied more to the lighter steel products, new business in the heavy section of the industry having been rather quiet. A little more business seems to have been transacted recently in Continental material. This is scarcely to be wondered at since the quotations are well below those for similar British steel. Continental joists are quoted at £6 17s. 6d.; steel bars at £6 10s. to £6 12s. 6d.; and steel plates at £8 7s. 6d., all delivered. The North-West Coast works have started the year in a good position, having orders on their books sufficient to keep them busy for practically the whole of the first half of the year.

The Midlands and South Wales.

One of the weak spots in the Midland steel markets is the light demand from the structural and heavy engineering branches. Irregular conditions rule in these sections of the industry, and whilst one or two establishments are ensured busy conditions for several weeks, others are poorly employed. At the moment there seems to be a scarcity of important contracts, which, it is alleged, is due in no small degree to the holding up of public work schemes. There has been some increase in business in boiler plates, arising from recent railway orders, and tentative efforts have been made to advance the price; but business is still possible at £8 5s. Active conditions rule in the lighter branches of the steel trade, and although there has been some diminution in the volume of business in small bars, it is thought that this is only temporary. A contributory cause, however, may be the competition of Continental steel bars at £6 10s. 9d. delivered, and including duty, against the British re-rollers' price of £7 10s. delivered and the steel makers' quotation of £7 15s. to £8. The demand for strip continues active, and although a fair business is passing in Continental material, it has not affected business in British strip, and some of the works have extended their delivery periods. Efforts are being made to bring this material under control, and a provisional price of £9 has been fixed. In South Wales conditions have been quiet since the holidays, and some anxiety is expressed at the slowness in the development of the export demand for tin-plates. This is beginning to affect the position at the steel works producing sheet and tin-plate bars. The structural engineering shops in South Wales are fairly well supplied with work, whilst most of the ship-repairing yards are busy.

Current Business.

Babcock and Wilcox, Ltd., report that during December they received more orders than in any period of five months during the past two years. This business included contracts in Great Britain, Japan, and South Africa, and comprised requirements for boilers and cranes totalling altogether over £500,000. Gibbon Brothers, Ltd., of Dudley, have received a contract from the South Durham Steel and Iron Company, Ltd., for a battery of twenty-two Gibbon Kogag coke ovens. Cochranes (Middlesbro) Foundry, Ltd., have decided, in order to provide space for the expansion and development of their spun and cast iron pipes and general foundry work at their Ormesby Ironworks, Middlesbrough, to dismantle blast-furnace plant containing in all three blast-furnaces, with stoves and auxiliary machinery. The space thus cleared will be used to extend the present foundry equipment. The Department of Overseas Trade reports that the following contracts are open for tender:—South African Railways and Harbours, supply of 998,684 lb. of flat spring steel; 3645 lb. of steel spring wire, and 249,830 lb. of round spring steel, also 432 steam pressure and 242 vacuum gauges (Johnannesburg, February 5th); New Zealand Posts and Telegraphs Department, 15,000 bolts, nuts, and washers, galvanised mild steel, 6½in. by ½in. (Wellington, February 12th); South Australian Government, Engineering and Water Supply Department, supply, delivery, erection, and complete installation of two centrifugal pumps, driven through step-up gears, together with exhausting pump for priming (Australia, February 13th); Argentine State Railways, supply, erection, and painting of fourteen spans for a railway bridge and dismantling of existing temporary bridges (Argentina, January 31st); Argentine State Oilfields, supply of fifteen pumps for the transfer of petroleum of duplex horizontal type, double-acting, capacity 10 cubic metres per hour, with casing 3½in. in diameter, exchangeable casings of 2½in., 3in., and 3½in. to be provided, working pressure with 2½in. casings 35 atmospheres; extra heavy side door elevators and latch elevators, sets of links of forged steel, reinforced spanners, extra heavy centre latch tubing elevators, automatic tubing hooks, sucker rod elevators. . . . . It is announced that orders for six 11,000-ton motor ships are to be placed by the Eagle Oil and Shipping Company with British shipbuilders. Contracts for two of the ships have already been given out to Tyne firms. The total value of the contracts is estimated at about £750,000.

Copper.

Business in electrolytic copper fails to expand in accordance with the hopes which were entertained at the end of the year. Consumers in this country, on the Continent and in the United States, seem disinclined to do anything but cover their immediate requirements. In America the price has receded somewhat, and the domestic quotation has dropped to 8 c., the export price falling to 7.97½ c., or £35 2s. 6d. to £35 5s. c.i.f. The only country which has shown any particular interest in the market has been Italy, and the demand from this quarter has been principally for rough copper for sulphate making. The delay in fixing the copper "code" is certainly having an unfavourable effect upon business, and consumers who at one time were disposed to cover in anticipation of an advance in values, now appear to doubt whether a practical working "code" can be devised. On the London standard copper market prices have displayed persistent weakness, but the turnover has been comparatively small. It is suggested that the weakness of the market may be partly due to the practice which some of the producers have pursued of entering into contracts at a price which may be fixed by the consumer on any day during the term of the contract at the London Metal Exchange quotation for the day. As a consequence, producers, to cover themselves, sell when prices advance, although this later on necessitates their making repurchases when the consumers pay.

Tin.

Uninteresting conditions have ruled in this market since the resumption of business after the holidays. Although the statistics were favourably received, their publication had little influence upon the market. At this season of the year purchases by consumers usually decline, with the result that the market takes on a somewhat apathetic appearance. American buying has been limited to comparatively small quantities, but hopes are still entertained that there will be a considerable increase during January, and that as a result deliveries, which for the past two months have been a little over 3000 tons, will greatly improve. In spite of the limited business transacted, the market has been firm this week and prices have moved within narrow limits. Negotiations are still proceeding between the International Tin Committee and producing countries outside the control scheme. Considerable interest attaches to the position of the Belgian Congo tin mines. These have been offered a quota, but are reluctant to become parties to the present scheme on the terms suggested for more than two years, as developments are in progress which, it is understood, will lead to a considerable increase in the production of these mines. It is expected, for instance, that the Government will undertake the improvement of transport facilities between the mines and the seaport and that this will be followed quickly by an increase in output. On the other hand the International Pool is credited with the view that the expectation of the Congo mines err on the side of optimism, and is understood to have offered a quota of about two-thirds the tonnage they demand. It is suggested that the indifference shown to the tin market by speculators is because other commodity markets have offered more attractive openings lately.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Hematite Mixed Nos.	3 2 6	3 0 0
No. 1	3 3 0	3 0 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	3 5 0	—
MIDLANDS—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 6	—
Basic	3 10 0	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	3 6 0	—
N.W. COAST—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow; 4 0 6 „ Sheffield; 4 5 6 „ Birmingham	

(*Basic iron prices subject to a rebate of 5/–.*)

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
LANCS.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
MIDLANDS—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. COAST—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
LONDON AND THE SOUTH—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	7 10 0	—
Plates, ¾in. (basis)	9 0 0	7 15 0
„ ⅝in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅜in.	9 15 0	8 10 0
„ ¼in.	9 7 6	8 5 0
NORTH-EAST COAST—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 7 6	7 0 0
Plates, ¾in.	8 15 0	7 15 0
„ ⅝in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅜in.	9 10 0	8 10 0
„ ¼in.	9 2 6	8 5 0
Boiler Plates, ¾in.	8 5 0	7 12 6
MIDLANDS, AND LEEDS AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 10 0	7 0 0
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅝in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅜in.	9 12 6	8 10 0
„ ¼in.	9 2 6	8 5 0
Boiler Plates, ¾in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
GLASGOW AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 15 0	7 0 0
Plates, ¾in. (basis)	8 15 0	7 15 0
„ ⅝in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅜in.	9 10 0	8 10 0
„ ¼in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
SOUTH WALES AREA—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 10 0	7 0 0
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅝in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅜in.	9 12 6	8 10 0
„ ¼in.	9 7 6	8 5 0

IRELAND—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 10 0	8 0 0
Plates, ¾in. (basis)	9 0 0	9 2 6
„ ⅝in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅜in.	9 15 0	9 17 6
„ ¼in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	8 15 0	8 15 0
14-G. to 20-G., d/d	10 0 0	9 0 0
21-G. to 24-G., d/d	10 5 0	9 5 0
25-G. to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/3 to 16/6.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic, Soft (25·41% C.)	6 0 0
„ Medium (0·42% to 0·60% C.)	6 17 6
„ Hard (0·61% to 0·85% C.)	7 7 6
„ „ (0·86% to 0·99% C.)	8 7 6
„ „ (1% C. and up)	8 17 6
Soft (up to 25% C.), 500 tons and up	5 5 0
100 tons	5 12 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/9 per lb.	
Ferro Tungsten	2/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 12 6	7/–
„ „ 8 p.c. to 10 p.c.	£21 12 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 10 0	9/–
„ „ „ 1 p.c. carbon	£35 12 6	10/–
„ „ „ 0·70 p.c. carbon	£37 10 0	12/6
„ „ „ carbon free	10½d. per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 0 0 to 17 10 0 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/– per lb.	

NON-FERROUS METAL.

Official Prices, January 10th.

COPPER—		
Cash	£31 5 0 to £31 7 6	
Three months	£31 7 6 to £31 10 0	
Electrolytic	£34 5 0 to £34 15 0	
Best Selected Ingots, d/d Birmingham	£35 0 0	
Sheets, Hot Rolled	£62 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10d.	10d.
„ Brazed (basis)	10d.	10d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
„ Brazed	11d.	11d.
TIN—		
Cash	£224 7 6 to £224 10 0	
Three months	£224 12 6 to £224 15 0	
LEAD:	£10 18 9 to £11 5 0	
SPELTER:	£14 6 3 to £14 11 3	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

		Export.
LANARKSHIRE—		
(f.o.b. Grangemouth)—Navigation Unscreened		13/3 to 13/6
„ Glasgow—	Ell	14/– to 16/–
„ „	Splint	17/–
AYRSHIRE—		
(f.o.b. Ports)—Steam		13/6
FIFESHIRE—		
(f.o.b. Methil or Burntisland)—Steam		15/–
Unscreened Navigation		12/6 to 13/–
LOTHIANS—		
(f.o.b. Leith)—Hartley Prime		14/– to 14/6
Secondary Steam		13/9 to 14/–

ENGLAND.

	Inland.
YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	17/6 to 20/6
Furnace Coke	13/– to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	14/6 to 15/–
„ Second	13/– to 13/3
„ Best Small	10/6 to 11/–
Unscreened	12/– to 13/6
DURHAM—	
Best Gas	14/8
Foundry Coke	17/– to 19/6
SHEFFIELD—	
Best Hand-picked Branch	27/– to 28/–
South Yorkshire Best	22/– to 24/–
South Yorkshire Seconds	17/6 to 19/6
Rough Slacks	6/– to 9/–
Nutty Slacks	7/– to 8/6
Furnace Coke (at ovens)	12/3

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/–
Foundry Coke	21/– to 36/–
Furnace Coke	18/6 to 20/–
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm	9/6 to 10/6
Steam Coals:	
Large	18/– to 20/–
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ½d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

A Hydro-electric Disaster.

As has been been previously stated in these notes, an installation was on the point of being completed in the Vosges to utilise the difference of level between two small lakes for the production of electrical energy during periods of peak loads, while for the rest of the time pumps returned water to the upper lake. The work has been carried on for some years by the Société Hydro-Electrique des Vosges, which receives supplies from Kembs, and the new installation was intended to be supplementary to that power station. The upper lake is the Lac Blanc at an altitude of 1054 m. It has an area of rather more than 60 acres. The Lac Noir, with an area of 35 acres, is 400ft. lower down. A tunnel about 1000 m. long terminates in a penstock of steel, 36 mm. thick, which branches out to four turbines, two of which had been running, and a third was being installed. At the time of the disaster on Friday of last week the pumps, driven by current from Kembs, were returning water to the upper lake, and with four pumps running the volume of water raised during the day would have been two million cubic metres. While the chief engineer, electricians, and mechanics were in the building, the penstock burst and the water rose like a geyser and broke through the roof of the power station, sweeping away nine of those inside into the lake. At the time of writing the bodies have not been found. Alarm was caused by the fear that the Lac Noir dam would burst under the pressure and destroy neighbouring villages, but, fortunately, nothing of the kind occurred. An attempt was made to close the gates in Lac Blanc, but one was wrecked and the other could not be operated. The flood subsided when the water level reached the tunnel. The damage done to the power station is considerable. There is, so far, no explanation of how the disaster could have occurred, except the theory that the pumps may have momentarily stopped and restarted against a falling head of water.

Shipping Subsidies.

A gloomy picture of French shipping is presented in the annual report of the Chargeurs Réunis, which attributes the depression of merchant shipping to a variety of social factors, such as the eight hours' working day on board ship and the heavier charges resulting therefrom, as well as to import quotas and high costs in France, as compared with those in other countries, while the fact that four-fifths of the world's sea-borne traffic is in the hands of countries that are off gold leaves French shipowners, it is said, helpless unless aided by the State. The report is really a plea for State assistance. The amount paid in subsidies is large, and the 1933 Budget provided for that purpose 126,700,000f. This money is distributed amongst a few companies which represent only a small proportion of the total French shipping tonnage. For a long time outside shipowners have agitated for similar assistance as offering the only means of saving their industry from disaster, and a Bill is now before Parliament for granting subsidies to all shipping on a progressive scale which will take into account the ship's tonnage, its speed, and the number of officers and men carried, the idea being to eliminate obsolete ships and encourage the construction of larger and faster ships in French yards. While it is hoped by this and other means to provide employment in home shipyards, it is, nevertheless, a grievance of shipowners that, according to the report of the Chargeurs Réunis, the rising costs in France have made the cost of shipbuilding about 60 per cent. higher than it is in foreign yards.

The Paris Water Supply.

The financing of the scheme to bring a million cubic metres of water a day to Paris from the Vals de Loire is to be undertaken by a Syndicat Général pour l'Alimentation en Eau de la Région Parisienne, which the Paris Municipal Council proposes to constitute with the aid of all the communes within the Department of the Seine, and of other communities that may desire to benefit from the supply. Already 152 communes have expressed their readiness to join the syndicate. The capital required for the undertaking is 2000 million francs, or more than £24,000,000 at the present rate of exchange. The plan for raising water from the deep sandy bed for a distance of about 40 miles along the Loire valley between Nevers and Briare, has been selected out of thirteen schemes submitted in competition. Wells are being sunk in different parts of the valley in order to make doubly sure that there is no error in the estimation of the volume and quality of water that can be drawn from it without risk of lowering the level of the river Loire. The fears of local inhabitants that this might occur are to be allayed by the construction of a dam which will impound enough water to provide for any emergency. When the General Syndicate has raised enough money to ensure the successful carrying out of the scheme, work will be started upon the sinking of wells and the laying of mains and collectors in the water-bearing sand. The aqueduct bringing the water by gravity from Briare to Paris will be nearly 100 miles long, and reservoirs will be constructed on the outskirts of Paris. It is estimated that the work will not be completed in less than five years, and may take considerably longer.

The Coal Tax.

The import tax on coal has been increased from 2f. to 4f. a ton, and is now applied to all categories of fuel, except coke for blast-furnaces. Foreign coal for the railways is no longer exempted from the tax. Imported anthracite is now subjected to a tax of 5f. a ton. These higher taxes and their general application coincide with the announcement by the Government of its intention to obtain powers to impose a tax on French coal production in order to create a relief fund for unemployed miners. It is a measure of protection as well as a means of raising fresh revenue, and is strongly resented by consumers, who fear that the tax on home coal production will still further increase the cost of fuel and will create a dangerous precedent for other industries. There will also be increased strictness in the distribution of import licences.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

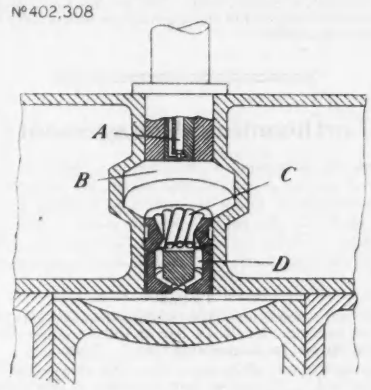
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

402,308. March 23rd, 1933.—PRECOMBUSTION CHAMBERS, Daimler-Benz Aktiengesellschaft, of Stuttgart-Untertürkheim, Germany.

The fuel injection valve of this crude oil engine is shown at A.

№402,308



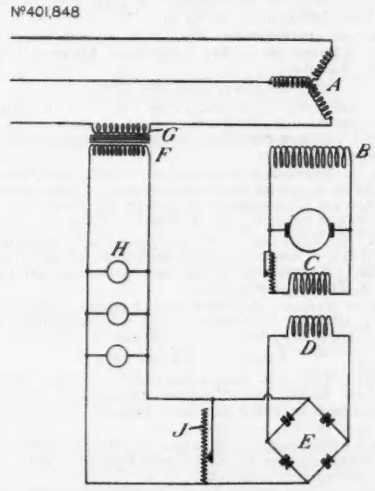
It discharges into a precombustion chamber B, from which the charge passes by the helically arranged passages C. It then goes through the "insertion" D to the working cylinder.—*November 30th*, 1933.

DYNAMOS AND MOTORS.

401,848. September 7th, 1932.—CHARACTERISTICS OF ALTERNATING-CURRENT DYNAMO-ELECTRIC MACHINES HAVING COMPOUNDING DEVICES, The Brush Electrical Engineering Company, Ltd., and Jeffrey Sutton Messent, both of Falcon Works, Loughborough.

The example of the invention illustrated is for maintaining the terminal electromotive force of an alternator (represented by the stator winding A and field winding B) approximately constant with varying loads of substantially constant power factor. On the exciter field system there is, in addition, a self-excited shunt connected winding C, a supplementary winding D, excited through a metal rectifier E from the secondary winding F of a current transformer, the primary winding G of which carries the current delivered by the alternator. With such an arrangement the self-excited field winding C of the exciter will produce excitation which is too nearly proportional to the exciter electromotive force, and the supplementary excitation will be too nearly proportional to the current delivered by the alternator. In order to ensure that the exciter shall be stable it is necessary so to design its magnetic system that the increment of exciter electromotive force produced for a given increment of exciter excitation decreases progressively as the excitation is increased. Moreover, if the alternator electro-

№401,848



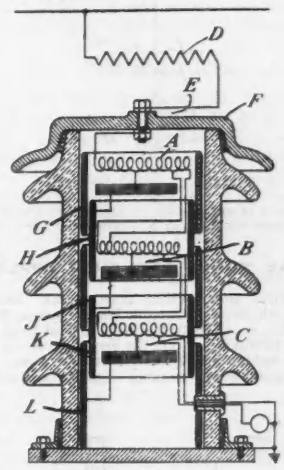
motive force is to be maintained constant, the increments of alternator excitation required per ampère of alternator current delivered are less at small loads than at large loads owing to the effects of magnetic saturation in the alternator itself. Accordingly, the increments of excitation which must be applied to the exciter in order to maintain constant alternator electromotive force with increasing load are much less at small loads than at large loads. If the system were designed to produce the same alternator terminal electromotive force at full load as at no load, then at part loads the E.M.F. would have higher values. One method of applying the invention to such a rectifier-compounded alternator and exciter would be so to design the current transformer F that its output under full-load conditions exceeds that required for the supplementary excitation of the exciter to maintain the same alternator terminal electromotive force at full load as at no load, absorbing the excess output in a metallic filament incandescent lamp H or lamps connected conductively and/or inductively in parallel with the rectifier E across the transformer secondary winding F. For purposes of adjustment a hand-operated rheostat J, the ohmic values of which do not vary greatly with temperature, may be connected in parallel with the lamps or barretters or in series with the rectifier E and field winding D.—*November 23rd*, 1933.

TRANSFORMERS AND CONVERTERS.

402,084. May 23rd, 1932.—HIGH-POTENTIAL TRANSFORMERS, *William Warren Triggs, of Marks and Clerk, 57 and 58, Lincoln's Inn-fields, London, W.C.2.*

This specification describes apparatus for diverting energy from high-potential transmission lines for voltage and current indication or for operating circuit breakers, &c., the high voltage of the line being reduced in a number of steps. The transformers A, B, and C are enclosed in a porcelain or other dielectric housing and are connected in chain or cascade formation. D is an absorbing resistance, which may be connected in series between the conductor and transformers. The incoming lead E may be connected directly to the end of the transformer winding A and to a metal cover F. With this arrangement the electrostatic capacity of the cover F to earth, or objects of lower potential, has a material advantage in permitting the voltage of a transient disturbance on the line to be partially absorbed in the resistance or impedance D. This shield also tends to distribute the electrostatic stress through the various trans-

№402,084

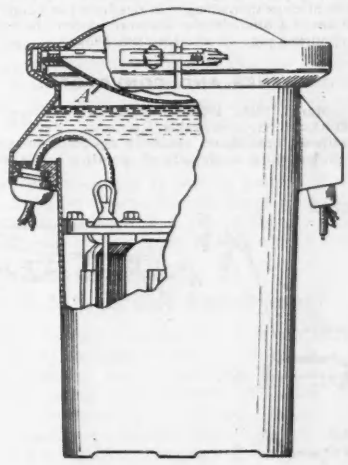


formers. While the shield F will tend to distribute the electrostatic stress at normal frequency, this distribution of stress is usually better controlled by the connections between the cores and their respective high-voltage windings. By connecting the high-voltage winding to the transformer core the potential of the core may be determined under normal conditions. Under a transient or high frequency surge, however, the impedance of the transformers is such that a concentration of voltage is likely to occur on the transformer nearest the line. This abnormal potential on the transformer is likely to cause a breakdown of the winding unless the transformer has very high insulation or means for overcoming this tendency is provided. Where the resistance D is large it is possible to absorb a very appreciable portion of the potential of a transient owing to the flow of current into the condenser formed by the shield F, and, if necessary, the capacity to earth E may be improved by the provision of additional condenser plates G H J K L.—*November 23rd*, 1933.

402,341. May 9th, 1933.—ELECTRIC TRANSFORMERS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.*

An improved method of sealing an oil-immersed transformer forms the subject of this invention. A flexible air-tight diaphragm A is provided within the transformer casing above the level of the liquid, the peripheral edge of the diaphragm being

№402,341



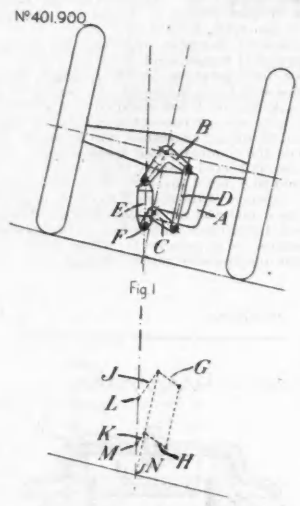
clamped between the cover and wall of the casing. The centre part of the diaphragm is preferably arranged normally to sag towards the surface of the liquid, and the space between the cover and the diaphragm is in free communication with the outside air. The arrangement is characterised by simplicity and by the elimination of means external to the casing for providing the sealing and expansion of the insulating liquid.—*November 30th*, 1933.

MOTOR CARS AND ROAD TRAFFIC.

401,900. December 12th, 1932.—AXLE SUSPENSION FOR ROAD VEHICLES, Michelin et Cie., Clermont Ferrand, Puy de Dome, France.

The object of this invention is to ensure that the load on the two wheels of one axle shall be equal even when the wheels are running on an inclined road surface. The axle is provided with a bracket A, to which two bell cranks B and C are pivoted. These are linked together at D and the load is transmitted to them by the part E. At F the pin works in a slot. The lengths of the two arms G H—see Fig. 2—of the bell cranks are equal.

The lengths of the two arms J K are proportional to the heights of the pivots L M above the ground. The result is that the

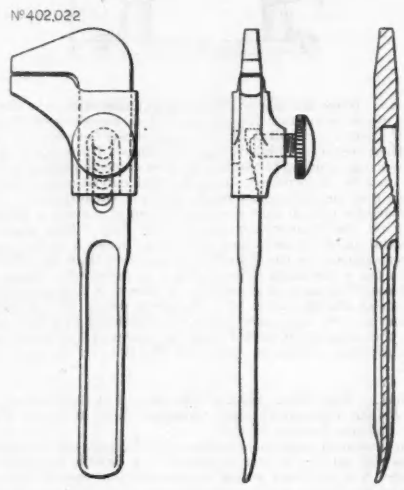


imaginary point of application of the load to the wheels always lies midway between them at N.—*November 23rd*, 1933.

MACHINE TOOLS AND SHOP APPLIANCES.

402,022. July 20th, 1933.—ADJUSTABLE SPANNERS, H. Worrall, 45, Beaks Hill-road, Kings Norton, Birmingham; and H. G. Lee, of 96, Arthur-street, West Bromwich.

According to this invention, the gripping jaws of the spanner or wrench are held in the adjusted position by means of a screwed pin on the movable jaw member engaging an inclined surface

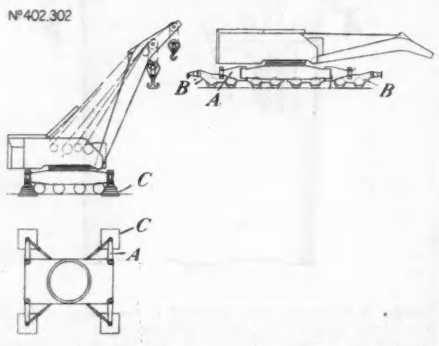


on the stationary jaw member. This inclined surface forms a wedge fixing or an abutment to prevent slip and therefore gives a substantially positive lock. The inclined surface preferably has a series of steps therealong or is roughened and conveniently the steps are of a semi-circular shape to receive the end of the screwed clamping pin.—*November 23rd*, 1933.

CRANES AND CONVEYORS.

402,302. March 16th, 1933.—BREAKDOWN CRANES, Ardeltwerke G.m.b.H., Eberswalde, Germany.

This railway breakdown crane is designed to give good mobility in travelling to the site of operation and a maximum

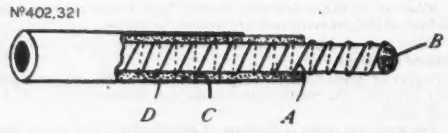


stability in working. At the four corners of its underframe there are pivoted arms A A, which can be used either to jack up part of the weight on to auxiliary bogies B B, or, when swung out broadside, to give a broad foundation, as shown at C C.—*November 30th*, 1933.

MISCELLANEOUS.

402,321. April 12th, 1933.—ELECTRIC RESISTANCE CONDUCTORS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.*

Armoured resistance elements constructed in accordance with this invention are suitable for any purpose, but are particularly suitable for heating. The resisting conductor A, which may be composed of any suitable material and in the form of a wire or band, is helically wound round a core B, which may consist of asbestos, glass wool, or any other insulating refractory material in the form of strands or fibres. C is insulation of a similar constitution to that of the core. Finally, a thin metal plate D is rolled round the insulation C, and the edges of the plate are bent over each other and soldered or assembled together



in any other way so as to form a tube armouring.—*November 20th*, 1933.

402,303. March 17th, 1933.—MECHANICAL JOINTS AND CONNECTIONS, P. Meyer, 17, Heemskerk-straat, Delft, Holland.

The inventor says that in the case of riveted joints the frictional resistance of the joint to parting should be so great that the rivets themselves are not subjected to shear. He consequently pastes over the faces of the joint with a "hard fine-grained powder," and in this way increases the coefficient from 0·02 to 0·65 in the case of steel plates. The invention is not confined merely to riveted joints. The specification is illustrated with several examples, but the drawings are unnecessary here.—*November 30th*, 1933.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. Mr. B. D. Parritt will introduce discussion on "Rubber and its Engineering Uses." 7 p.m.

INST. OF METALS: SHEFFIELD LOCAL SECTION.—The University, Sheffield. "Protection from Corrosion of Aluminium and its Alloys," Mr. N. D. Pullen. 7.30 p.m.

INST. OF PRODUCTION ENGINEERS.—Merchant Venturers' College, Bristol. "Modern Foundry Production Methods," Mr. J. J. Shechan. 7.30 p.m.

INST. OF STRUCTURAL ENGINEERS.—At James Watt Memorial Inst., Birmingham. "Foundations," Mr. G. B. P. Pimm. 6.30 p.m.

INST. OF TRANSPORT: NEWCASTLE-UPON-TYNE AND DISTRICT SECTION.—"Future Developments in Air Transport," Mr. W. L. Runciman.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1.—"Colour Light Signals for Road Traffic," Mr. H. J. N. Riddle. 7.30 p.m.

KEIGHLEY ASSOC. OF ENGINEERS.—Queen's Hotel, Keighley. "Spiral Bevel Gears," Dr. H. E. Merritt. 7.30 p.m.

MANCHESTER ASSOC. OF ENGINEERS.—At Engineers' Club, Manchester. "The Electrical Equipment of a Large Iron and Steel Works," Mr. W. Redfern. 7.15 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—At Mining Inst., Newcastle-upon-Tyne. "Shipbuilding in relation to Subsequent Repairs," Messrs. E. and E. P. Wilson. 6 p.m.

RAILWAY CLUB.—57, Fetter-lane, E.C.4. "Why the L. and N.W. Railway was the Premier Line," Mr. J. D. Godfrey. 7.30 p.m.

SOC. OF CHEMICAL INDUSTRY: PLASTICS GROUP.—At Chemical Soc., Burlington House, W.1. "Plastics as Engineering Material," Mr. Herbert W. Rowell. 8 p.m.

SATURDAY, JANUARY 13TH.

INST. OF CIVIL ENGINEERS.—Students' afternoon visit to Croydon Aerodrome.

INST. OF MARINE ENGINEERS: JUNIOR SECTION.—Social and dance. 7.30 p.m. to 11.15 p.m.

INST. OF PRODUCTION ENGINEERS.—Castle-street Hall, Luton. "Functions of the Production Engineer." Mr. J. Ronald. 7.30 p.m.

MONDAY, JANUARY 15TH.

INST. OF AUTOMOBILE ENGINEERS.—At Inst. of Engineers and Shipbuilders, 39, Elmbank-crescent, Glasgow. "Development of a Constant-Periodicity Suspension System," Mr. S. A. Horstmann. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND CENTRE.—James Watt Memorial Inst., Birmingham. "Some Aspects of the Electrical Transmission of Power by Means of Super-tension Direct Current," Mr. H. Rissik. 7 p.m.

INST. OF MECHANICAL ENGINEERS.—Joint meeting with Sheffield Soc. of Engineers and Metallurgists, at the University, Sheffield. "Examination of Materials by Radium and X-rays," Dr. V. E. Pullin. 7.30 p.m.

INST. OF METALS: SCOTTISH LOCAL SECTION.—39, Elmbank-crescent, Glasgow. "Factors in the Solidification of Molten Metals," Dr. Sydney W. Smith. 7.30 p.m.

TUESDAY, JANUARY 16TH.

BRITISH ASSOC. OF REFRIGERATION.—At Inst. of Marine Engineers, 85–88, The Minories, London, E.C.3. "Some Chemical Aspects of Refrigeration," Major F. A. Freeth, F.R.S. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Hotel Metropole, Leeds. "A.C. Crane Control and Operation," Mr. H. Thompson. 7.15 p.m.

INSTITUTIONS OF MECHANICAL AND ELECTRICAL ENGINEERS: GRADUATE AND STUDENT SECTIONS AND LONDON STUDENTS OF CIVIL ENGINEERING.—Joint Dance at Victoria Halls. 7.30 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—James Watt Memorial Inst., Birmingham. "Electric Welding," Mr. C. A. Hadley. 7 p.m.

INST. OF TRANSPORT.—London meeting. "The British Coasting Trade and its National Importance," Mr. J. R. Cowper.

MANCHESTER GEOLOGICAL AND MINING SOC.—At Mining and Technical College, Wigan. "Firedamp and some of its Characteristics," Mr. C. McLuckie. 3.30 p.m.

WEDNESDAY, JANUARY 17TH.

DIESEL ENGINE USERS ASSOC.—At Caxton Hall, S.W.1. "The Report of the Committee on Heavy Oil Engine Working Costs (1932–33). 3 p.m.

INST. OF AUTOMOBILE ENGINEERS.—Metropole Hotel, Kingstreet, Leeds. "Repairs," Mr. J. Dent. 7.15 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Discussion, "Transition Curves and Superelevation on Roads," Mr. E. L. Leeming. 6 p.m.

INST. OF PRODUCTION ENGINEERS.—At James Watt Memorial Inst., Birmingham. "Electrical Machinery and the Production Engineer," Mr. B. Pringle. 7 p.m.

MANCHESTER METALLURGICAL SOC.—Joint Meeting with Inst. of British Foundrymen, Engineers' Club, Manchester. "Bearing Metals," Mr. A. J. Murphy.

NEWCOMEN SOC.—At Iron and Steel Inst., 28, Victoria-street, S.W.1. "The Reverberatory Furnace with Coal Fuel, 1612–1712," Mr. Rhys Jenkins. 5.30 p.m.

N.E. COAST INST. OF ENGINEERS AND SHIPBUILDERS: GRADUATES.—Bolbec Hall, Newcastle-upon-Tyne. "Experiments on a Hydraulic Reaction Turbine," Mr. K. Fairbairn. 7.15 p.m.

ROYAL METEOROLOGICAL SOC.—49, Cromwell-road, S. Kensington. Annual general meeting. 7.30 p.m.

ROYAL MICROSCOPICAL SOC.—B.M.A. House, Tavistock-square, W.C.1. Presidential address, "Some Recent Advances in Microscopy," Mr. Conrad Beck. 5.30 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C. "Modern Developments in Street Lighting," Mr. J. M. Waldram. 8 p.m.

SOC. DES INGENIEURS CIVILS DE FRANCE: BRITISH SECTION.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Port of Algiers and the Mustapha Jetty," M. Bénézit. 6 p.m.

THURSDAY, JANUARY 18TH.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C.2. "Some Aspects of the Electrical Transmission of Power by Means of Super-tension Direct Current," Mr. H. Rissik. 6 p.m.

INST. OF PRODUCTION ENGINEERS.—At 39, Elmbank-crescent, Glasgow. "Advantages of the Latest Cutting Materials," Mr. W. Muirhead. 7.30 p.m.

INST. OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W.1. "Portland Cement Specifications," Major Alan Moncrieff. 6.30 p.m.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. "The London Building Act of 1930 and its Effect on Structural Design," Mr. W. C. Cocking. 7 p.m.

LIVERPOOL ENGINEERING SOC.—Adelphi Hotel, Liverpool. Annual dinner. 7 p.m. for 7.30 p.m.

N.E. COAST INST. OF ENGINEERS AND SHIPBUILDERS: TEESSIDE BRANCH.—At Cleveland Scientific and Technical Inst., Corporation-road, Middlesbrough. "Electric-welded Ship 'Peter G. Campbell,'" Mr. N. M. Hunter. 7.30 p.m.

ROYAL AERONAUTICAL SOC.—At Royal Soc. of Arts. John-street, Adelphi, W.C.2. "Ethyl," Mr. F. R. Banks. 6.30 p.m.

FRIDAY, JANUARY 19TH.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. "Presentation and Discussion of a Symposium of Papers Dealing with Invention." 6 p.m.

INST. OF STRUCTURAL ENGINEERS.—At Merchant Venturers' Technical College, Bristol. "Design of Welded Structures," Mr. C Helsby. 7.15 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Some Modern Developments in Fire Extinguishment," Mr. E. C. Prince. 7.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse by Mr. G. Elliot Smith. 9 p.m.

UNIVERSITY OF LONDON.—King's College, Strand, W.C.2. "Apparatus for Power Factor Correction," Mr. D. B. Hoseason. 5.30 p.m.

SATURDAY, JANUARY 20TH.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Visit to works of John Lumb and Co., Ltd., glass bottle manufacturers, Castleford. 3.15 p.m.

INST. OF MARINE ENGINEERS: JUNIOR SECTION.—Visit to Battersea Power Station. 10 a.m.

MONDAY, JANUARY 22ND.

INST. OF MECHANICAL ENGINEERS: GRADUATES.—Storey's-gate, S.W.1. "New Cutting Alloys," Mr. C. R. Perks. 6.45 p.m.

INST. OF STRUCTURAL ENGINEERS.—At S. Wales Inst. of Engineers, Cardiff. "Cinema Construction in Steelwork," Mr. G. E. Cooper. 7 p.m.

TUESDAY, JANUARY 23RD.

INST. OF ELECTRICAL ENGINEERS.—At 39, Elmbank-crescent, Glasgow, C.2. "Some Aspects of the Electrical Transmission of Power by means of Direct Current at Very High Voltages," H. Rissik. 7.30 p.m.

INST. OF MARINE ENGINEERS.—The Minories, E.C.3. "The Origin and Development of Heavy Oil Engines," Akroyd Stuart Award (1933) Paper, Mr. S. Hicks. 6 p.m.

STEPHENSON LOCOMOTIVE SOC.: SCOTTISH BRANCH.—Royal Technical College, Glasgow. "Some Railway Travels," illustrated by lantern. Mr. John McInnes. 7.45 p.m.

WEDNESDAY, JANUARY 24TH.

INST. OF FUEL.—St. Ermin's Hotel, S.W.1. Informal meeting, discussion, "Oil as an Ally of the Coal Trade." 7 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C. "Modern International Practice in Factory Design," Mr. Hal Williams. 8 p.m.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

THE G.W.R. has purchased a 70 H.P. Diesel shunting engine from John Fowler and Co. (Leeds), Ltd., for use in the yard at Swindon locomotive works.

THE SUNBEAM MOTOR CAR COMPANY, Ltd., Wolverhampton, has received an order from the Bournemouth Corporation for twelve six-wheel electric trollybuses. It is anticipated that the new route on which these vehicles will operate will be opened in June.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

GREENWOOD AND BATLEY, Ltd., have appointed Mr. W. H. Tyce, 1, Kymin-terrace, Penarth, Glam., as their technical representative in South Wales.

SIR ALEX. BINNIE, SON AND DEACON, Artillery House, Artillery-row, Victoria-street, Westminster, S.W.1, have altered their title to Binnie, Deacon and Gourley.

BRUCE PEEBLES AND CO., Ltd., inform us that Mr. G. L. Kirkpatrick, general manager, has been appointed managing director of the company, as from January 1st, 1934.

FLANNERY, BAGGALLAY AND JOHNSON, Ltd., inform us that Mr. Alfred James Boyton and Mr. Edwin Hart joined their board of directors on January 1st. Mr. Boyton and Mr. Hart have each been in the service of the company for over a quarter of a century.

HENRY SIMON, Ltd., Cheadle Heath, Stockport, inform us that Sir Ernest Simon, the present chairman, is resigning, and will be succeeded by Mr. Cecil Bentham, M. Inst. C.E., M.I. Mech. E., M. Inst. T., who has been managing director of the firm since 1926.

A Seven-Day Journal

A French Air Disaster.

A REGRETTABLE air disaster occurred at Corbigny, near Vichy, some 120 miles from Paris, on Monday evening, when the Air France Company's monoplane "Emeraude," returning from Indo-China, made a forced landing and struck a high-tension cable. The machine took fire and all on board were burned. They included Monsieur Pierre Pasquier, the Governor-General of French Indo-China, and several Government officials and representatives of the Air France Company. The "Emeraude" was one of a number of Dewoitine D 332 three-engined air liners, which were ordered last year for the Paris-Lyons service. They have a designed speed of 150 miles per hour, a landing speed of over 60 miles per hour, and a range of 1200 miles. The ill-fated machine left Le Bourget on December 22nd and arrived in Saigon on December 29th, after making a record flying time of forty-eight hours for 7140 miles. She started from Saigon on the return journey a week last Friday, but was delayed with engine trouble. On Monday evening she left Lyons at 6.15 for Paris, and her last message received at Lyons at 8.10 p.m. was that she was flying at a height of 4800ft. in a severe snowstorm. It is thought that the machine was forced to land owing to the formation of ice on the wings. The fire was so intense that nothing could be done to save the occupants of the aeroplane.

Southern Railway Electrification.

A CONTRACT valued at over £150,000 for sub-station equipment on the Southern Railway Company's main line electrification extension, referred to in our issue of December 8th, has been awarded to Bruce, Peebles and Co., Ltd., of Edinburgh. The new scheme involves electrification from Wivelsfield and Brighton to Eastbourne and Hastings and from Haywards Heath to Horsted Keynes, at a cost of £1,750,000. The Bruce-Peebles contract is for the supply and erection of twenty-three rectifier equipments, together with three-phase transformers for reducing the pressure of the incoming A.C. supply, switchgear, and auxiliary plant. Each rectifier is to have a normal capacity of 2500 kW and to be capable of carrying overloads of 8000 kW. The experience gained with metal-cased rectifiers on the London to Brighton line has apparently been satisfactory, and there is every indication that this class of apparatus is rapidly gaining favour in the railway world.

Welders in Shipyards.

A GENERAL conference between representatives of the Shipbuilding Employers' Federation and the shipyard trade unions, which was held at Edinburgh on Wednesday last week, was called to discuss the proposal of the employers for the creation of a new skilled class of shipyard worker to be known as shipwelders; it ended in a deadlock. The independent chairman, Mr. T. Graham Robertson, K.C., who presided, had been in close touch with both parties since the last conference in November, and separate and informal discussions had taken place. At Wednesday's meeting, Mr. G. T. Edwards, the President of the Employers' Federation, made a statement involving certain modifications to the earlier proposals, while Mr. W. Sherwood presented the case on behalf of the trade unions. The employers' contention, it may be recalled, is that a new class of shipyard welder is needed, while the unions maintain that the need can be met by an extension of the training of apprentices within existing grades of workers. On no agreement being reached, Mr. G. T. Edwards intimated that the matter was not one which the Federation was prepared to refer to arbitration. It is not anticipated that the two parties will meet again to discuss the matter, and should no further meeting take place the general conference will be closed on Friday, January 19th.

Road Vehicles.

A RETURN has been issued by the Ministry of Transport, and published by the Stationery Office, which gives particulars of the gross receipts from the taxation of road vehicles for the period from December 1st, 1932, to November 30th, 1933, and of the number of motor vehicles registered for the first time during the month of November, 1933. The gross amount received in payment for licences issued during the twelve months ended November 30th, 1933, was £29,201,133, compared with £28,431,766 in the corresponding period of the preceding year. The gross amount is subject to deductions in respect of rebates, refunds, statutory deductions, including the costs of collection and administration, and the proportion due to the Exchequer, under the Finance Act, 1926, from the net receipts of the taxation of motor cycles and vehicles taxed on horse-power. Particulars are given of the total number of licences issued and surrendered during the twelve months to November 30th, 1933, and of the approximate numbers of licences current on that date. The total number of motor vehicles, excluding tramcars and trade vehicles, was approximately 2,013,800, compared with 1,926,600 in the corresponding period of the previous year. The total number of the mechanically propelled road vehicles registered for the first time in November, 1933, was 23,815, compared with 20,146 in November, 1932.

Steelmakers and Re-rollers.

SOME confusion has arisen regarding the scheme for an understanding between the steel makers and the re-rollers, which has been circulated amongst the members of these two branches of the steel industry. The scheme is the result of discussions early last year between a committee of the steel makers and the re-rollers, and although it fits into the plan of the National Committee, it is not specifically mentioned in it. The proposal made to the re-rollers that a part of the scheme relating to prices should be adopted by them for a period of six months looks rather like an attempt to put into operation proposals suggested in principle in the National Committee's scheme before it has been accepted either by the industry or the Government. The usual procedure is adopted of dividing the country into districts, consisting of Scotland, the North-East Coast, Lancashire and Cheshire, Lincolnshire and Yorkshire, South Wales and Monmouthshire, and the Midlands. The scheme provides that a rise or fall of 2s. 6d. per ton in the price of billets should be followed by a similar movement of 3s. per ton in the price of steel bars, angles, &c. In the event of any firm in the Association which is a party to the suggested agreement being unable to obtain sufficient supplies of billets, it may purchase its requirements abroad upon obtaining the permission, accorded by a 75 per cent. majority, of the Joint Committee of Re-rollers and Billet Makers entrusted with the supervision of the scheme. In such circumstances, it can claim a refund of the difference in price it may have to pay from the Joint Committee. Firms outside the scheme are to be charged not less than 10s. more for their billets than those who are a party to it. There seems to be considerable opposition to these proposals, possibly as a result of the rise in the cost of billets and the consequent advance in the price of re-rolled finished steel which has taken place this year.

The Federation of British Industries.

AT a meeting of the Grand Council of the Federation of British Industries, held last week, Lord Herbert Scott was nominated to succeed Sir George Macdonogh as President of the Federation for the coming year. Lord Herbert Scott was President of the London Chamber of Commerce in 1928, an office which he held until 1931, when he was elected Vice-President of the Association of British Chambers of Commerce. He is a director of Rolls Royce, Ltd., the Tilbury Contracting and Dredging Company, Ltd., United Glass Bottle Manufacturers, Ltd., and the deputy chairman of Cellulose Acetate Silk, Ltd. At the same meeting the Grand Council heard statements on the position of British shipping by Sir Alan Anderson and Sir Ernest Glover. As a result of the facts put before it the Council passed a resolution which deplored the serious position in which British shipping has been placed by State building and subventions in many foreign countries, combined with the restriction of world trade. It urged the Government to treat the subject as one of the highest importance and urgency.

Strengthening Weak Bridges.

PRELIMINARY lists of weak bridges have been deposited by the railway companies with the Ministry of Transport under Section 30 of the 1933 Road and Rail Traffic Act. The Act requires that a month's notice be given of any proposed restriction on the use of a weak bridge, and a list open to public inspection to be kept of all bridges upon the use of which restrictions are to be imposed. It is hoped that the strengthening of such bridges will be looked upon as an object for which the Road Fund can find the money, and there seems to be some likelihood of the Ministry of Transport inclining to that view. Meanwhile the Association of British Chambers of Commerce has addressed a letter to the Minister of Transport, in which it is stated that the Executive Council of the Association has had under its consideration representations from Chambers of Commerce on the failure of the Government to implement the recommendations of the Royal Commission on Transport with regard to the reconstruction of weak bridges in order to meet the requirements of modern transport. The Association is of the opinion that in the circumstances the time has arrived when the Government should accept the responsibility for the introduction of a bold programme on the lines recommended by the Royal Commission and approved by the Conference on Road and Rail Transport.

London's Water Supply.

ON Friday, January 12th, a special meeting of the Metropolitan Water Board was held to deal with the extraordinary circumstances created by the drought. Sir William Prescott, the Chairman of the Board, presided, and a report of the Works and Stores Committee was submitted by Sir George Handover, who described a special scheme to expedite supplies to East London. Sir William Prescott dealt with the conditions during the last nine months, and said that the new scheme provided for pumping Thames water into the Lee Valley watershed. The sum of £52,500 was voted for the works, and it is understood that the plants will be set to work within the next ten weeks. It will comprise four sets of 750 B.H.P. oil engine-driven centrifugal pumps, which will be installed at the Kew Bridge works, and two similar sets of pumps at the Battersea works, as well as some vertical spindle low-lift pumps for pumping water from the filter beds at Hanworth-road works to the pumping station at Kempton Park. A connection between the "Henry Ward" pumping engines at Hampton and Kempton Park will be made, and at each station appropriate connections to mains, relief valves, &c., will be provided. The new plant, while designed to meet the temporary East London needs, will be available later for use on the new scheme of distribution which in the near future must inevitably be carried out.

New Naval Orders.

THE Admiralty announcement of the contracts for the eight destroyers of the 1933 programme comes, as was anticipated, somewhat earlier than originally expected. Two destroyers are to be built by each of the following firms:—The Fairfield Shipbuilding and Engineering Company, Ltd., of Govan, Glasgow; Alexander Stephen and Sons, Ltd., of Linthouse, Glasgow; John I. Thornycroft and Co., Ltd., of Woolston, Southampton, and Vickers-Armstrongs, Ltd., Barrow-in-Furness. The destroyers are of the "G" class, and will have a displacement of about 1375 tons. The armament will comprise four 4·7in. guns, with a 3in. anti-aircraft gun and eight 21in. torpedo tubes. The geared turbine propelling machinery will have a designed output of about 36,000 S.H.P., and will be designed for a speed of about 35½ knots. Each ship will carry about 450 tons of oil fuel. The total value of the eight contracts is stated to be about 2½ million pounds. The remaining ships of the 1933 programme include two 9000-ton cruisers, one 5200-ton cruiser, two submarines, and three sloops, which, with the exception of one or two of the smaller ships, will all be constructed outside the Government dockyards. On Tuesday, January 16th, the submarine "Severn" was safely launched at Vickers-Armstrongs' Barrow Yard, the naming ceremony being performed by Mrs. Forbes, the wife of Vice-Admiral C. M. Forbes, the Third Sea Lord, and Controller of the Navy.

A New Light Machine Gun.

THE decision of the Indian Army Authorities to re-arm the cavalry with the Vickers-Berthier light machine gun suggests that this new weapon, which has undergone, and is still undergoing, War Office tests, will, in future, be an important arm of the British Services. It is simple in construction, easy to manipulate, and only weighs 10 kilos., complete with its bipod fitting, and 23 kilos. with a tripod. It combines in one weapon the functions of the light automatic gun carried and fired by one man, and those of the heavy rifle calibre machine gun. When used as a light weapon, it is generally fired from the bipod, or from the shoulder or hip, the tripod fitting being reserved for the heavier machine gun duties. The ammunition is contained in a sector-shaped magazine, which is quickly clipped to the gun and carries thirty rounds. A change of magazine takes only two seconds, while only eight seconds are needed to replace a barrel. By the movement of a lever near the trigger, the gun can be used either as an automatic weapon, or for deliberate single shots. It can be employed to fire 300 rounds in a minute, which time includes the changing of magazines, and for deliberate firing a trained man can make up to ninety aimed shots in a minute.

An L.M.S. Bridge Replacement.

A GIRDER bridge carrying the L.M.S. Railway's Cricklewood–Acton branch line over Acton-lane, near Harlesden Station, was successfully replaced by a new 215-tons steel and concrete structure during Sunday last, January 14th. The new bridge, which has been installed to enable heavier locomotives to be employed on the line, and which consists of steel girders floored with concrete, was previously assembled on trestling adjoining the existing structure. At 7.30 a.m. on Sunday morning, work was begun on the demolition of the old bridge, the girders of which were cut up by oxy-acetylene and removed piecemeal. As soon as the last remains of the old bridge had been removed the new one was rolled into position along the temporary trestling. In order to enable this to be carried out smoothly and swiftly the new bridgework was mounted on ball bearings. The engineers and some eighty workmen, together with two large cranes—a 36-tons steam crane on the railway line, and a mobile crane operating from the roadway—two steam locomotives, and a train of ballast wagons were engaged on the work, which occupied practically the whole of the day. During the operations traffic under the bridge was diverted. By Monday morning, trains were running over the new bridge.

The Development of the Parsons Steam Turbine.

No. III.

(*Continued from page* 34, *January* 12*th*.)

THE CAMBRIDGE TURBINE (*continued*.)

SINCE the Cambridge turbine of 1891 marked practically the culminating point of the development of the radial flow design, it is of historic interest to give a fairly full account of the machine, particularly as the opportunity is thereby afforded of noting the degree of evolution of the mechanical details peculiar to turbine machinery. A photograph of the unit is reproduced in Fig. 10 and a sectional view in Fig. 11. The construction was so well described by Professor Ewing, F.R.S., in connection with careful tests of the machine which he carried out during August, 1892, that the following extract from his report may be quoted.

"The turbine case contains a series of seven revolving discs from the surface of which the turbine blades project. They are arranged on each disc in a series of concentric rings. The fixed guide plates stand in spaces between these rings, being carried by annular discs which are fixed to the case. Thus each revolving disc with its neighbouring fixed disc forms a series of outward-flow turbines, the steam entering the series inside the smallest ring of blades and escaping at the circumference into a channel which conducts it between the back of the revolving disc and of the next fixed disc to the inside of the next series of rings. The heights and apertures of the turbine blades on each disc are adapted to the increasing volume of the steam as it expands from an absolute pressure of 115 lb. per square inch to an absolute pressure of 1 lb. per square inch. The first six discs, which are each 15in. in diameter, are designed to expand the steam to about atmospheric pressure, the remainder of the expansion being performed in passing the seventh disc, which is 26¾in. in diameter and has (unlike the other six) a double series of rings of blades, one series on each side, through which the steam flows in parallel.

"The height to which the turbine blades project above the discs in which they are secured varies from $\frac{3}{16}$in. to 1in. The whole number of moving rings in the machine tested was 35. The blades are made of strong sheet brass and show no sign of wear after continued use. Steam enters the turbine case at one end through a double-beat valve, and after passing the successive turbine discs is discharged to a condenser. The longitudinal pressure on the turbine shaft, due to the one-sided character of the six smaller turbine discs, is balanced at the high-pressure end by a revolving baffle piston with a number of deep grooves on its circumference, which are entered by corresponding projections on a fixed bush resembling a thrust block. Any small amount of longitudinal thrust which may remain unbalanced is received by an adjustable grooved thrust bearing at the end of the spindle beyond the main bearing. The thrust bearing consists of seven collars on the spindle revolving in a grooved bush which is split longitudinally into halves, with separate longitudinal adjustment to allow any wear to be taken up so that end shake is prevented and the endwise position of the shaft is maintained with great precision. This device also gives a means of regulating the amount of clearance over the tips of the turbine blades. The thrust bearing, like the main bearings, runs in a bath of oil.

"The main bearings are of a special construction, which is admirably adapted to ensure easy running at high speed and to damp out vibration. The shaft rotates in a phosphor-bronze sleeve, outside of which are slipped three concentric steel tubes fitting to set over one another. The outermost tube is a loose fit in the casting, which forms the seat of the bearing. Oil is continuously and freely fed to the bearing from a cistern above, under a head of some 6in., and drains into a chamber below from which it is automatically pumped back to the cistern. The oil is used over and over again. In this way the small clearance between each tube or sleeve and the one outside of it is kept charged with a film of oil, with the effect that while the shaft retains a necessary small amount of freedom to adjust itself by lateral displacement, the viscosity of the film acts as a powerful damper to prevent oscillation from being set up. The working of the bearing is perfectly satisfactory, and the damping action is so great that the shaft may even be put considerably out of balance without causing the vibration to become excessive or making the bearings run hot.

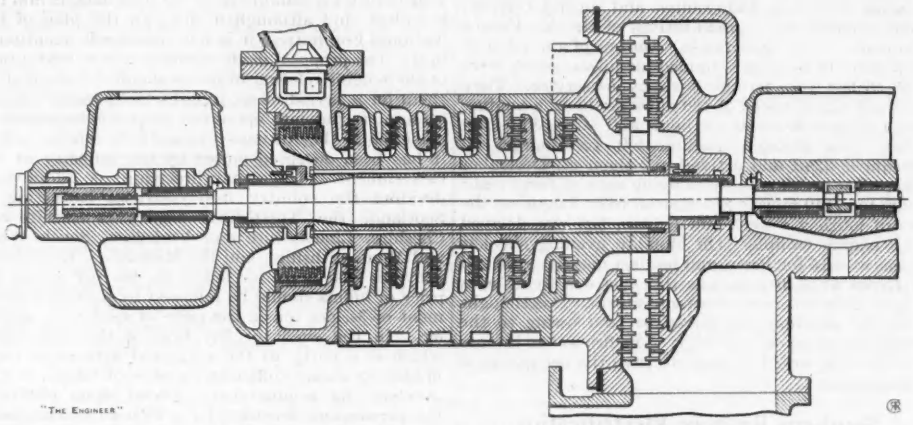


FIG. 11—SECTIONAL ELEVATION OF CAMBRIDGE TURBINE

The oil chambers are connected by pipes so that a single oil pump maintains the circulation in all. The pump is driven by an excentric which receives its motion from a worm on the main shaft working in oil between the main bearing and the thrust bearing."

The description quoted above indicates a considerable advance in design. The previous method of making the blades by cutting them from the solid was superseded by the employment of individual blades stamped to shape from sheet brass. The blades were held in rings of brass, slotted to receive the blade-roots, which were thickened by "upsetting" so as to provide a more secure hold. After the insertion of the blades the foundation rings were caulked into grooves turned in the discs. The dummy piston

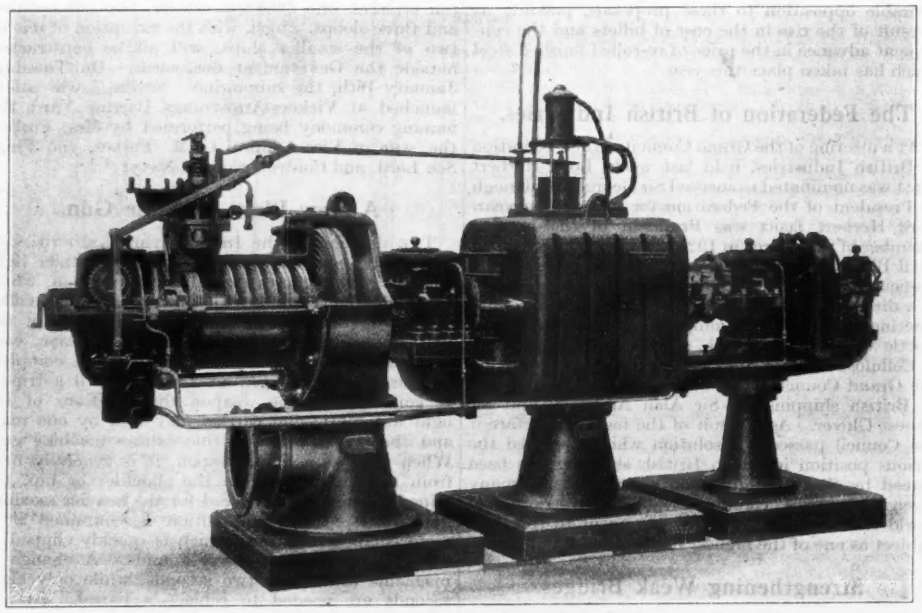


FIG. 10—THE CAMBRIDGE TURBINE OF 1891

FIG. 13—DE LAVAL'S "HERO" ROTOR

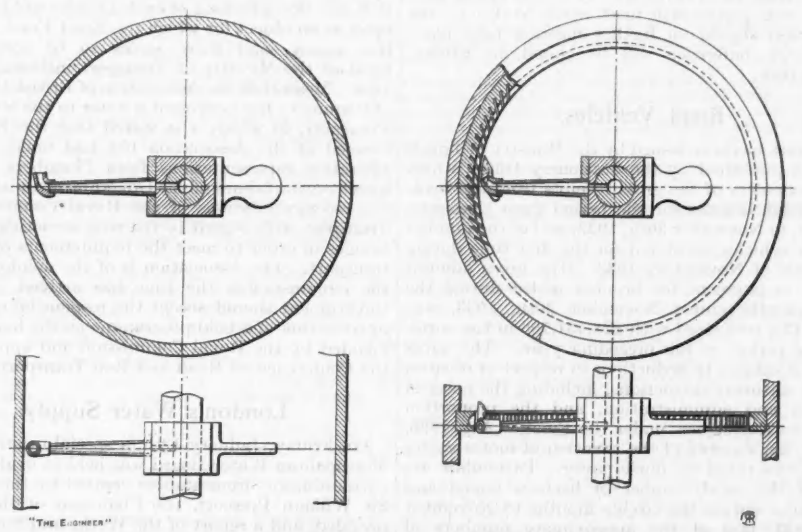


FIG. 12—PARSONS MODIFIED "HERO" TURBINE

also was elaborated by serrating the working faces of the fixed baffle-rings by seven grooves per ring, with the idea of increasing the resistance to steam-leakage past the piston. The advantage gained was, however, so slight in comparison with the extra complication involved, that the plan was afterwards abandoned.

The method of fixing and at the same time providing for accurate longitudinal adjustment of the rotor by means of a split thrust-block, was, on the other hand, an improvement which characterised all steam turbines for many years afterwards, and, indeed, became universal until the invention of the pivoted-pad thrust-block somewhat altered the nature of the problem. The rotor of the Cambridge turbine was so set that the clearance over the blade tips was one-hundredth of an inch. The fact that the turbine was built for condensing service made it important to avoid all leakage of air round the shaft where it emerged from the casing at the low-pressure end. For this purpose a steam-packed gland was devised, another innovation, the principle of which has been retained ever since. Steam at a low pressure, very slightly above that of the atmosphere, was led to an annulus round the shaft. It could only escape by leaking through the gland in both directions along the shaft. So long as any steam at all was escaping outwards, it was certain that no air could be flowing inwards and thus spoiling the vacuum in the turbine casing.

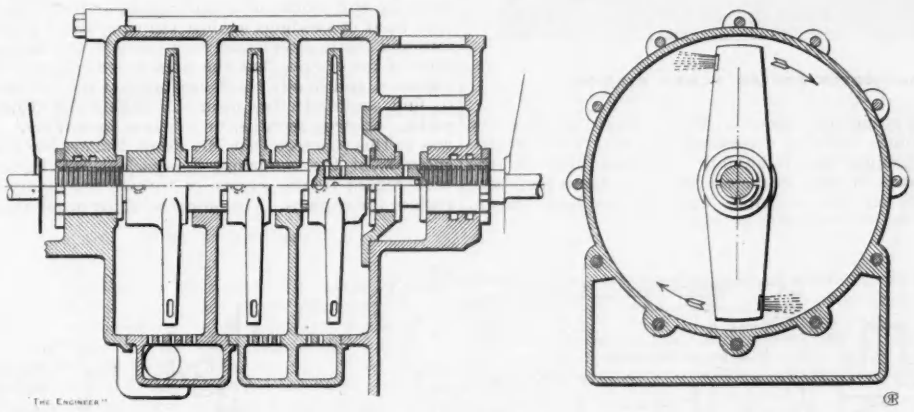


FIG. 14—PRESSURE-COMPOUNDED "HERO" TURBINE

The turbine had no centrifugal governor. The double-beat throttle valve controlling the inlet of the steam was operated by a steam relay, this being one of the very earliest examples of relay governing. The relay spindle was actuated by one end of a long lever, the other end of which was attached to the plunger of a solenoid excited by the current from the exciting dynamo of the alternator. The fulcrum of the lever was not fixed, but attached to the end of another lever, which was maintained in continual oscillation by the excentric which drove the lubricating pump. Steam was, therefore, admitted to the turbine in gusts, the quantity entering, at each gust, being regulated by the action of the solenoid. The principle of "gust" governing, as it was called, remained characteristic of Parsons turbines for many years, its great merit being that as the gear was continually in motion, it was extremely sensitive to control, either by a centrifugal governor or a solenoid, so that not only was sticking prevented, but an extremely fine speed regulation was possible.

In view of the historical importance of the Cambridge turbine, the following particulars of the unit are of interest, particularly as they indicate the state of the art of steam turbine construction in the year 1891. It will be noted that at the normal speed of 4800 r.p.m. the peripheral velocity of the last wheel was as high as 565ft. per second, a really remarkable speed for so early a machine.

Particulars of the Cambridge Turbo-generator.

Rated capacity	100 kilowatts
Revolutions per minute	4800
Nature of current	1 ph. 80 ~, 2000 volts
Steam pressure	140 lb. per sq. in.
Steam temperature (saturated)	361 deg. Fah.
Vacuum at full load	26·5in., baro. 30·00in.
Steam consumption at full load	37·0 lb. per kWh
Steam consumption at half load	39·0 lb. per kWh
Overall length of unit	14ft.
Overall breadth	3ft.
Total weight without condenser	4 tons
No. of wheels	7
No of blade rings—	
First three wheels	4 each
Next three wheels	3 each
Last wheel	2×7
Diameter of first six wheels	15in.
Diameter of last wheel	26·75in.
Type of condenser	Jet

NOTE.—With steam at 100 lb. gauge pressure and 465 deg. Fah., and a vacuum of 28·75in., the steam consumption was 27 lb. per kWh at full load and 30 lb. at half load.

EXPERIMENTS WITH TURBINES OF THE "HERO" TYPE.

Before leaving the subject of radial flow turbines, a brief reference may be made to Mr. Parsons' experimental work on turbines of the "Hero," or pure reaction, type. The original turbine of Hero of Alexandria was caused to revolve by the reaction of steam escaping freely from a pair of nozzles tangential to the motion of the rotating part. Dr. Gustave de Laval used a turbine of this kind having an S-shaped rotor, in his earliest experiments in 1883 (see Fig. 13). He applied it to the driving of cream separators, which required high speed and small power, the drive being effected by means of friction bevel wheels. De Laval, however, soon abandoned the Hero principle, and turned his attention to the simple impulse type of turbine devised by Branca in 1629. This he converted into a practical machine, and by his invention of the divergent nozzle in 1887 he developed an efficient prime mover.

Others besides de Laval had worked on turbines of the Hero type, and several were constructed in the first half of the nineteenth century, notably by Dr. Wilson, of Greenock, and Avery, of Syracuse, in the United States. They were applied to the driving of circular saws and cotton gins. In his presidential address to the Birmingham and Midland Institute in 1922, Sir Charles Parsons referred to these machines and to his own experiments along similar lines. In the course of the address in question, he said: "The tubular arms of these wheels were 2ft. 6in. long, of an oval or streamline section. The nozzles were non-divergent, and the peripheral speed 880ft. per second. The steam consumption is not recorded,

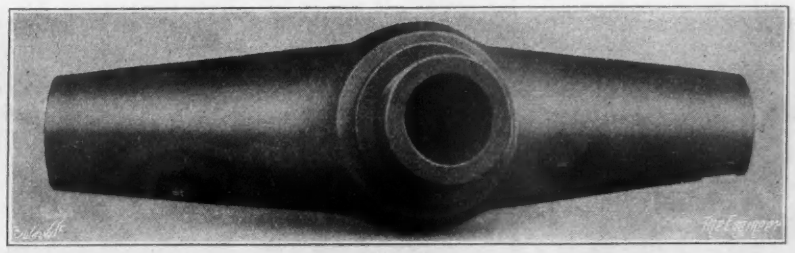


FIG. 15—WHEEL OF "HERO" TURBINE

but we may calculate that it would be very much inferior to that of any ordinary piston-engine. One of these machines was at work at Greenock for some years, driving a circular saw. To test the possibilities I constructed one in 1893 with divergent nozzles, and when tested with steam at 100 lb. pressure, and with the jets revolving at 800ft. per second, in a chamber with a good vacuum, it was found to give about the same efficiency as a good single-cylinder reciprocating engine."

The steam was introduced into the hollow shaft of the machine by radial holes on each side, and steam-tightness was secured by means of a labyrinth packing. The power developed was about 16 kW at 5000 revolutions per minute. Mr. Parsons was not satisfied with the results obtainable with the simple "Hero" turbine, but did not discard the principle without further investigation. In order to improve the machine he reconstructed it in the modified form shown in Fig. 12. A wide brass ring was mounted inside the casing. On the inner surface of this ring was turned a deep semi-elliptical groove. The groove was traversed by saw cuts inclined at an angle, and into these cuts were fitted plates of sheet brass, which thus divided the groove into a series of cups, similar to those which were used in the later Riedler-Stampf turbines. At the end of the rotating arm were brazed a set of three corresponding cupped blades. The steam jet issuing tangentially from the nozzle at the end of the arm entered the fixed cups at one side, and passing round them was returned to the moving cups on the arm of the machine. The moving cups acted, therefore, as impulse blades to extract the residual velocity of the steam. By this arrangement it was hoped to secure an efficiency superior to that obtainable from the simple reaction jet of the Hero wheel. Difficulties, however, arose owing to the centrifugal forces of the heavy headpiece and cupped blades which limited the speed of revolution. A consideration of the design will show how nearly Mr. Parsons came to the principle of "velocity-compounding" subsequently employed by Mr. C. G. Curtis in machines

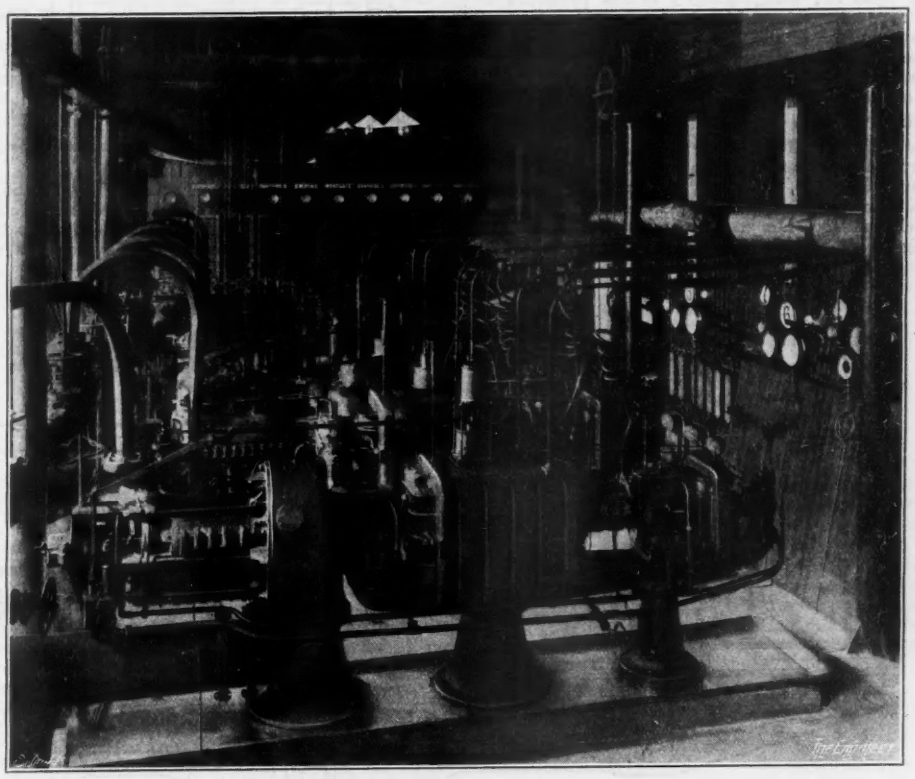


FIG. 16—FORTH BANKS POWER STATION IN 1892

of the parallel-flow type, but he was at this time precluded, as already explained, from constructing parallel-flow turbines.

A further effort was made by Mr. Parsons to improve on the simple "Hero" turbine by introducing the principle of pressure-compounding. By distributing the total fall of pressure over a number of "Hero" wheels in series on the steam-flow, the pressure-drop at the nozzles of any one wheel would be lessened and the velocity thus be reduced to a more manageable value. The whole turbine thus consisted of a number of chambers, each containing a Hero wheel. The steam, after being partially expanded in the first wheel, re-entered the shaft and passed through the arms and nozzles of the second wheel, and so on. Several of such machines were built, some with three and others with five pairs of arms, but the principle was not considered satisfactory owing to the frictional resistance of the arms revolving in the steam contained in the chambers. Drawings of a three-stage machine are reproduced in Fig. 14, and a photograph of one of the wheels in Fig. 15.

It will be recognised that during the five years from 1889 to 1894, when Mr. Parsons had, perforce, to interrupt the development of his original parallel-flow turbine, he nevertheless carried out much valuable and interesting work along such lines as were still open to him. His efforts, moreover, had to be made with the consciousness that they were not being directed to the perfection of the type of turbine which he knew to be the best. The economy of the best radial-flow turbines was some 12 per cent. lower than that of a normal parallel-flow machine under either condensing or non-condensing conditions.

The Reversion to the Parallel-flow System.

In the year 1894, an event took place which exercised a profound influence on the history of the steam turbine. In that year Mr. Parsons made arrangements with Clarke, Chapman and Co., Ltd., which enabled him to employ the principles of design which he had felt from the beginning of his inventor. Hence, with the restoration of his liberty in design, the radial flow principle was immediately abandoned, and such useful experience as had been gained with it was applied to the development of machines on the original system of parallel flow.

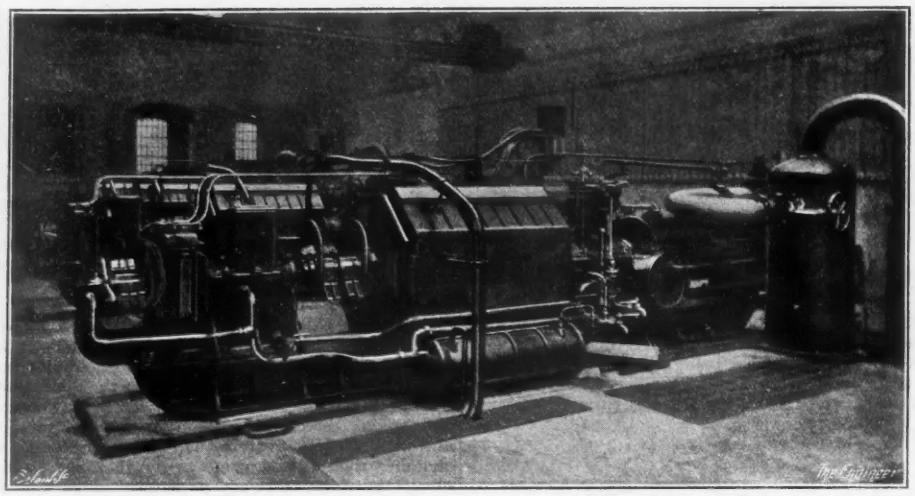


FIG. 17—350 KW TURBO-ALTERNATOR IN MANCHESTER SQUARE POWER STATION

The photograph of Forth Banks Power Station of the Newcastle and District Electric Lighting Co., taken in 1892, which is reproduced in Fig. 16, is interesting as showing the original parallel-flow turbines built at Gateshead in 1887, while in the foreground are radial-flow machines built at the Heaton Works. Some scores of machines had been built on this principle, and, as has been shown, Up to the time of the temporary loss of the parallel flow patents in 1889, the aggregate capacity of the turbines built at Gateshead on this principle was about 4200 kW, the largest individual units being of 75 kW capacity. Production naturally received a check, while the radial flow system was being developed, yet larger units were constructed, the maximum for land service being 150 kW, as already mentioned. The reversion to the parallel flow principle in 1894 gave an impetus to development, and one of the first machines of this kind built at the Heaton Works was designed for a rated output of 350 kW at 3000 revolutions per minute. The set in question was supplied to the order of the Metropolitan Electric Supply Company, of London, for service in their Manchester-square generating station. Its size, in those days, was regarded as enormous, and the fact that an electric lighting company decided on a steam turbine for so important a unit, showed how firmly Mr. Parsons invention had established itself in the ten years which had elapsed since his first patent.

The primary reason for the installation of turbine machinery at the Manchester-square Station was the necessity for doing something to mitigate the nuisance caused by the reciprocating engines. In 1893 the station contained ten Willans high-speed central valve engines exhausting to atmosphere through a 16in. pipe carried to the top of the chimney shaft. Residents in the neighbourhood complained strongly of the noise and vibration of the engines and ultimately took legal proceedings against the company. Elaborate and costly alterations were made to the foundations of the engines, but the work failed to abate the nuisance, and finally the Court ordered the company to find some effective means of curing the trouble within eighteen months, or to cease operations. It was at this juncture that Mr. Frank Bailey, the chief engineer of the company, approached Mr. Parsons with regard to the supply of turbine machinery to replace the engines. The outcome of the negotiations

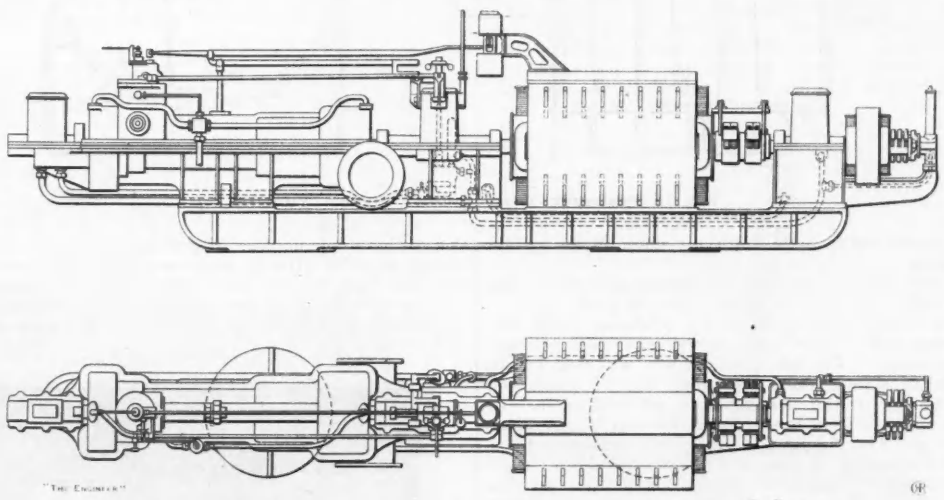


FIG. 19—GENERAL ARRANGEMENT OF MANCHESTER SQUARE TURBO-GENERATOR

sufficient success had been attained to establish the steam turbine as an efficient, reliable and convenient prime mover, but the limitations of the radial flow type had become more than evident to its was the order, in April, 1894, for a 350-kW single-phase Parsons turbo-alternator to run at 3000 revolutions per minute and generate current at 1000 volts and 100 cycles. It was to work with steam at 150 lb.

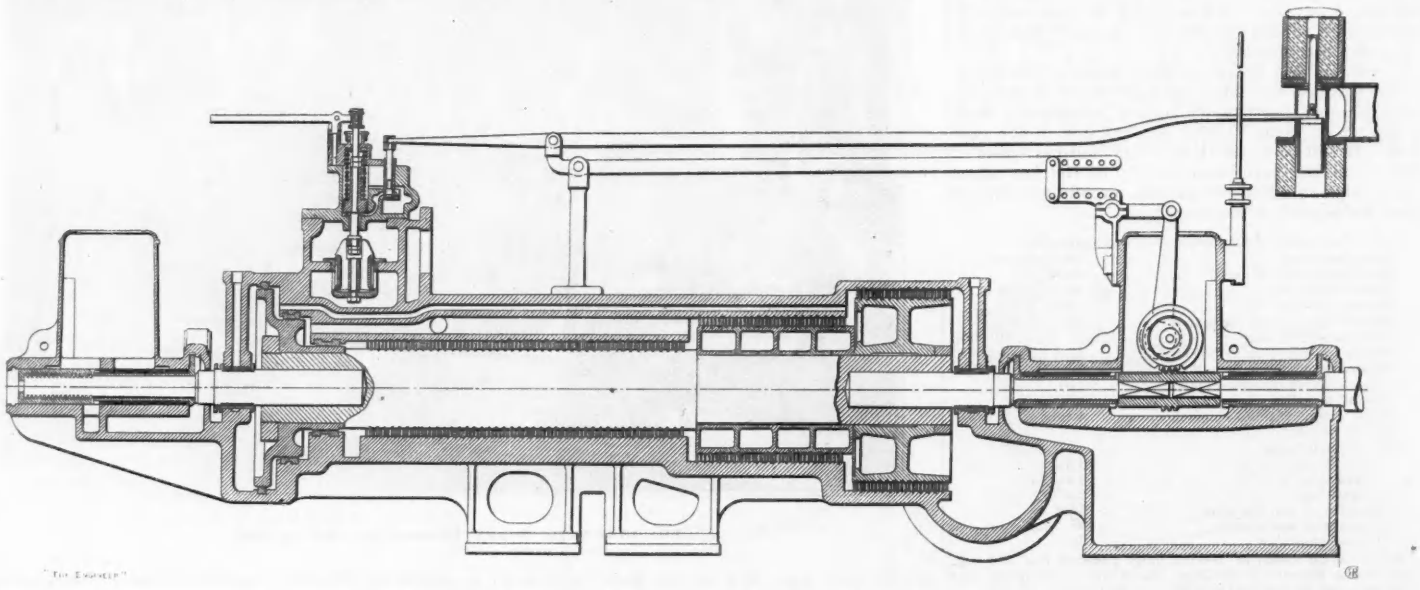
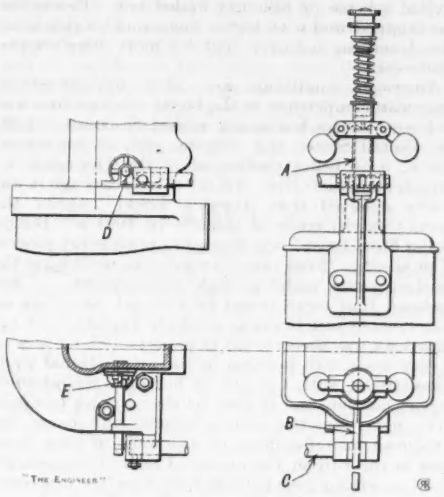


FIG. 18—SECTIONAL ARRANGEMENT OF 350 KW PARALLEL FLOW TURBINE

work to be most favourable to the development of turbine machinery. The most valuable of the rights regained was that of using the system of parallel flow. For five years he had been compelled to limit his energies to the exploitation of the radial flow prin- per square inch, very slightly superheated, and to exhaust to atmosphere like the other engines. The machine, although constituting so large an advance on previous experience, was delivered and put into service ahead of the contract time, and gave to Man-

chester-square the credit of being the first power station in the Metropolis to employ the new type of prime mover. A view of the station with the turbo-alternator in the foreground is shown in Fig, 17. The result was so satisfactory that two additional sets were immediately ordered. Within a year or two a pair of 500-kW units was installed by the same company in its Amberley-road Station, and these were followed by other turbo-generators in the Sardinia-street and Willesden stations of the company.

The general arrangement of the Manchester Square unit is shown in Fig. 19, while a sectional drawing of the turbine is reproduced in Fig. 18. The blading was arranged on three diameters of the rotor. The steam was admitted through the double-beat valve and



FIGS. 20 AND 21

entered the turbine all round the spindle, passing successively through the three diameters of the blading and passing to atmosphere through the exhaust branch in the lower half of the casing. At the left-hand end of the rotor were the three dummy pistons, each balancing the end thrust of the steam on the corresponding section of the blading. The blading was of a somewhat primitive design, all blades being uniformly 1in. in length. They were cut from the solid out of Delta metal bars, which were afterwards bent to the curvature of the rotor and casing, the blades projecting like the teeth of a comb. The curved lengths of blade strip were afterwards caulked into grooves in the rotor and casing. A glance at the illustration is sufficient to show how great an

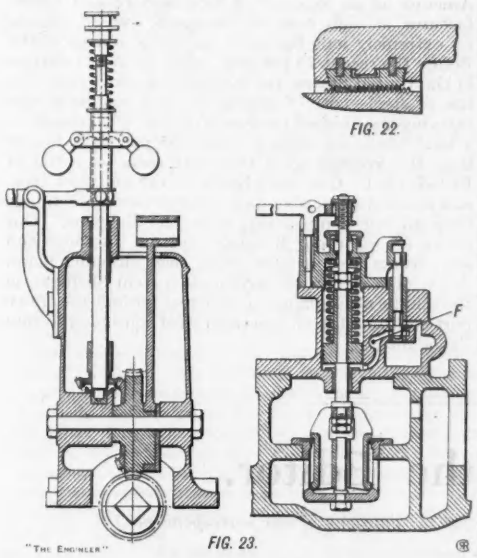


FIG. 22.

FIG. 23.

FIGS. 22 AND 23

evolution had taken place since the construction of the original steam turbine ten years earlier. The stepped drum to accommodate the increasing volume of the steam; the single-flow arrangement to halve the blade tip leakage and to shorten the machine; the dummy pistons and balancing ports to take care of the end thrust, and the provision of labyrinth packings to replace the smooth glands previously used, were all important steps in advance. The sleeve bearings, invented by Mr. Parsons in connection with the original turbine, were adhered to, and indeed remained standard practice for many years afterwards.

Reference to the sectional drawing Fig. 18 shows that the increased diameter for the intermediate and low pressure sections of the rotor was obtained by shrinking rings of metal on to the drum forging, which was of almost uniform diameter throughout. The design is almost strangely prophetic of the modern practice of using shrunk on wheels to carry the last rows of blading, although the motive now is very different. The use of the worm driving the oil pump and governor gear as a muff coupling is an example of the inventor's ingenuity, as it not only saved length, but fitted in most admirably with the lubricating requirements of the worm gear, the two bearings and the coupling itself. As regards the bearings, it will be noted that the journal ran in a bronze bush prevented from rotating by a lug at the end which was held by the bearing cap. The bush was surrounded by three concentric brass sleeves fitted loosely over each other, so that oil films existed between them The bush was thus able to adjust itself within certain limits, the arrangement thus being self aligning and also conductive to the suppression of vibrations.

The manufacture of the labyrinths to give practical steam-tightness to the glands and the dummy pistons was an example of Mr. Parsons ingenuity. The shaft was placed in position and melted lead or solder then run in between casing and shaft. The latter was furnished with V-shaped projections where the labyrinths were required, and the small necessary running clearances were obtained by rotating the shaft. In the case of rubbing taking place owing to axial displacement of the rotor when the machine was in service, the soft metal wore away without causing any trouble or damage. An enlarged section of part of the H.P. dummy showing the labyrinth arrangement is given in Fig. 22.

The turbine was controlled by a "gust governor," which admitted the steam in blasts, longer or shorter according to the load on the machine. Attached to the spindle of the double-beat throttle valve was a piston, which was normally pressed downwards by a spring above it. Steam leaking at a slow but determined rate through the bushing of the spindle raised the pressure below the piston and so tended to keep the valve open in opposition to the action of the spring. A small relay valve, with a reciprocating motion, allowed the steam to escape periodically, and thus kept the double-beat valve also in reciprocating movement. This relay valve was actuated by levers from an excentric driven by worm gearing from the main shaft. The connection, however, was not direct, the position of the fulcrum end of the operating lever being controlled by a solenoid. This solenoid was excited by a current proportional to the voltage at the terminals of the alternator. Any drop in the machine voltage thus had the effect of altering the stroke of the relay valve in such a manner as to increase the weight of each blast of steam into the turbine. A centrifugal governor of the Hartnell spring-loaded type was fitted to shut the turbine down in emergency. It operated by releasing the steam under the piston of the double-beat valve and so allowing the spring to hold the valve permanently shut.

Details of the governor and valve are given in Fig. 23, and these, in connection, with Figs. 18 and 21, should make the mechanism clear. The emergency shutting down device operated on exactly the same principle as is employed in modern turbines, although steam pressure instead of oil pressure was released in the case of the Manchester Square machine. Reference to Fig. 21 will show that when the turbine developed excessive speed the balls of the centrifugal governor flew out and lifted the sleeve "A." The rise of the sleeve lifted the ends of the forked lever "B" and caused a partial rotation of the rod "C." A tongue piece "D" on the end of this rod engaged with a valve stem "E" controlling the port "F," shown on Fig. 23, therefore causing the valve to open, releasing the steam pressure on the underside of the piston of the double beat valve, and allowing the spring to shut the latter valve instantly.

The coupling between the turbine and alternator was of the muff type, but the limit of the capacity of such a coupling to give satisfactory service was nearly reached, so that when the 1000-kW Elberfeld turbines were designed a few years later a new type of coupling had to be devised. The alternator itself was a four-pole machine with stationary field. Natural ventilation was employed. The exciting dynamo was directly coupled to the end of the alternator.

Drawings of the armature and the ventilating fan of the Manchester Square alternator are reproduced in Fig. 24. This machine probably constituted the earliest example of the use of a ventilating fan mounted on the rotor. The fan consisted of a brass casting with a large number of holes, ⅜in. diameter, drilled tangentially through the rim from the outside. The fan was fixed at the end of the armature nearest the turbine, and drew air longitudinally through core from the exciter end. The construction of the commutator of the exciter shown in Fig. 24 is also interesting. Although the design is of so early a date, it was very successful and was used for many years. It appears to be the forerunner of the "V" ring type, as the same principle is adopted for holding the segments together. The method of holding the segments by means of rings shrunk over the commutator was not developed until later, and it will be noted that no special means of balancing was provided in the commutator illustrated.

(To be continued.)

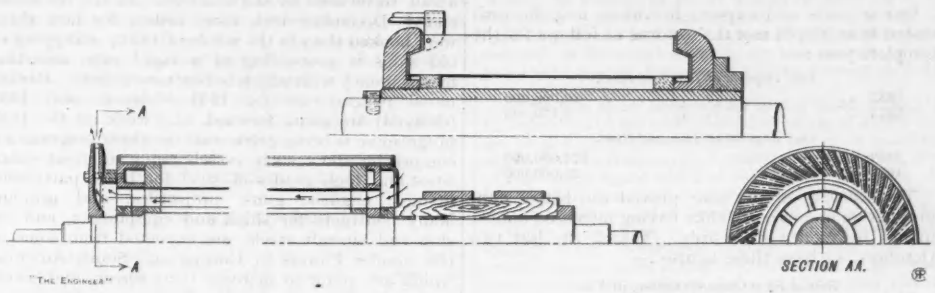


FIG. 24—DETAILS OF MANCHESTER SQUARE ALTERNATOR

The Steel Trade: British and Foreign.

By E. T. GOOD.

THE world's iron and steel trade is passing through interesting developments, and the British branch of it seems to be making the most solid progress. This is remarkable, because for some thirty or forty years, until quite recently, our industry stagnated, showing little or no headway in output or exports, though the world's demand for iron and steel increased enormously. Our own market became a dumping ground for our competitors. Foreign-produced and subsidised tram rails were laid in our streets whilst skilled steel workers of our own walked the same streets unemployed. Conditions have changed. They are still in process of change.

Taking first the world's biggest producing country, the United States of America, we see an extraordinary spectacle. We see that huge country, holding vast resources in iron ore and coal, occupying an insignificant position in the iron and steel export trade, beaten by Britain, France, Germany, and even Belgium. Little more than thirty years ago America was making amazing headway in the production and exportation of iron and steel and engineering products. She was first in production. She was second in exports, and looked like quickly taking the lead. British and other European manufacturers took alarm. To-day, American competition counts for little in any market outside the United States, with the exception of next-door Canada, and in that market American steel products are being seriously challenged by British products.

Taking a general world survey, we see some revival from the deep depression. Steel production in 1933 may prove to be about one-third more than it was in 1932; slightly less than in 1931, and far less than in the record year 1929. The following figures indicate the position, though they cannot be guaranteed as exactly accurate:—

World's Steel Production, Partly Estimated.

	Tons.
1913	75,000,000
1925	89,000,000
1926	91,000,000
1927	100,000,000
1928	108,000,000
1929	120,000,000
1930	95,000,000
1931	69,000,000
1932	50,000,000
1933	67,000,000

America is chiefly responsible for the big rise and fall in production. In the rest of the world conditions have been more even in the last twenty years. In 1929 America made 56,000,000 tons of steel, but

less than 14,000,000 tons in 1932. Some actual figures for the last three years are as follows :—

Steel Production, in Tons.

	1931.	1932.	1933.
Britain	5,202,600	5,261,400	5,639,000 (ten months)
United States	25,945,500	13,681,100	19,516,500 (ten months)
Germany	8,087,900	5,647,800	6,030,400 (ten months)
France	7,698,100	5,550,900	4,935,700 (nine months)
Belgium	3,056,000	2,764,600	2,074,800 (nine months)
Luxemburg	2,002,800	1,924,600	1,536,200 (ten months)
Russia	5,330,000	5,800,000	6,000,000 (estimated)

The rise, fall, and recovery of British industry is shown herewith :—

British Steel Production, Monthly Averages, in Tons.

1913	638,600
1929	803,000
1930	608,200
1931	433,500
1932	438,100
1933 (first nine months, average)	552,300
1933 (October)	668,300
1933 (November)	695,000

Our imports and exports in values may be estimated from eleven months' returns as follows for the complete year :—

Our Imports of Iron and Steel.

1932	£9,000,000
1933	5,750,000

Our Exports of Iron and Steel.

1932	£27,000,000
1933	28,000,000

The last half of the year proved the better half, production and exports alike having increased almost month by month since July. Taking the last two Octobers, we have these figures :—

British Steel Output, October, in Tons.

1932	439,800
1933	668,300

British Iron and Steel Exports, October, in Tons.

1932	172,500
1933	226,700

Foreign competition is well checked in the home market, our imports now consisting of little except grades of material not produced here. Our exports comprise such a big percentage of high-grade or special steels and products that their cash value per ton is more than twice as much as the value per ton of our imports. Tonnage figures show Germany, France, and even Belgium (with Luxemburg) greater exporters of iron and steel than the United Kingdom ; but in value of exports we have a decided lead, for the iron, steel, and products we ship range from 100 to 250 per cent. higher in value per ton than the exports of other countries.

Our increase in exports tonnage and value, in recent months, is not due to any considerable extent to increased business with foreign countries, but to better trade in the Dominions and Colonies. There is, however, high probability of an early and pronounced increase in our exports to foreign countries. At the moment, however, we have Empire trade to thank mainly for the improvement in exports. To Australia we are exporting more, and have the certainty of more orders from the Commonwealth, financial, labour, and political matters there having greatly improved, and we are booking business which formerly went to the United States and the Continent. Canada is making less steel for herself, much reducing her imports of American products, and taking increased quantities from the Old Country. New Zealand is an improving market. Railway extension schemes in South, East, and West Africa are going forward, and will cause contracts to be placed with us. India, with big railway and other steel-using schemes planned before the war, but mostly suspended these last twenty years, is almost chronically short of railway mileage, equipments, and rolling stock. A special Commission has reported emphatically in favour of huge expenditure on Indian railways. With the Indian steel plants very inadequate to meet the enormous demand that must materialise shortly, and with the new fiscal preference for British steel and products, our exports to India may easily eclipse the highest past record in the near future. In Denmark, Sweden, and Norway, we have better chances through the recently made trade treaties ; but to foreign countries in the bulk we are sending very little steel or products, save special grades. Trade barriers are higher than ever in most countries. However, there are several foreign countries without steel industries of their own, countries which require great quantities of steel and steel goods, countries which, if not emerging from financial depression, are getting so desperately short of railways and other things needing steel that they will be bound greatly to increase their purchases very soon, and with British steel more competitive than usual against Continental and American steels, many and substantial orders will come our way. Brazil, Argentina, other Latin Republics, Finland, and China may be mentioned as particularly promising customers for our products.

Home Market Conditions.

Increased home railway and shipbuilding demands served in the closing weeks of the year to do more than counterbalance the seasonal decline in the call for structural steel and steel for agricultural implements. The home demand for all-steel, or mainly steel, omnibuses, and the overseas demands for British commercial road vehicles and pleasure cars and cycles, are more than counterbalancing the seasonal decline in the home demand for motor cars, and our manufacturers are busy on all sorts of steels and parts for automobiles of one kind or another. Steel is being increasingly substituted for wood in railway sleepers, in railway trucks and coaches, in omnibuses, for props and beams in mines, and for window frames, staircases, and ceiling supports in houses. Home railway groups, after restricted buying for a few years, are going to spend about £10,000,000 on steel rails, sleepers, fish-plates, bolts, locomotives, and all-steel, or nearly all-steel, wagons. All the money will be spent on British materials and products.

A definitely widening avenue for British steel is the shipbuilding industry. In it there are two changes which are "bull" points for steel. One is a real and probably big revival in shipbuilding, naval and mercantile, which means an increasing demand. The other is that, ship for ship, more steel than ever is about to be used by shipbuilders. In the six weeks ended December 16th more orders for new ships were booked than in the whole of 1932 ; scrapping of old ships is proceeding at a rapid rate, and this means money with which to buy new vessels. British naval programmes for 1931 (delayed) and 1932 (delayed) are going forward, and work on the 1933 programme is being given out, the three programmes comprising about sixty vessels requiring great quantities and high grades of steel for hulls, partitions, fittings, engines, guns, projectiles, and armour. Many contracts for ships and equipments, and for ship and aircraft steels, are expected from some of the smaller Powers in Europe and South America, which are going to increase their forces, and which have not the necessary manufacturing and construction plants of their own for the work.

A few years ago, to meet foreign competition in ship steel, our steel makers launched a rebate scheme, offering rebates or repayments of from 5s. to 10s. per ton in respect of steel supplied to shipbuilders, conditional upon the builders using no imported steel over stipulated periods. The scheme has worked fairly well. Little steel has since been imported for shipbuilding. Now the new tariff and the higher prices of foreign steel, coupled with amalgamations of steel and shipbuilding firms, or interlocking agreements between them, result in the shipbuilding industry relying almost entirely on home-made steel. But there are other factors. Because of fires on shipboard, less wood and more steel is being used for cabin partitions and furnishings. Because of several disasters due to wooden hatches breaking under heavy seas, steel hatches are coming into favour. Because of the relative costliness of wood and cheapness of steel, and the great lightness of steel as recently improved in quality, steel is being more and more used instead of wood for decks. The all-steel ship is within sight. The elimination of foreign steel, the increasing use of steel in place of wood in shipbuilding, and the definite increase in the demand for new ships, combine to give promise of much more employment for steel makers.

Foreign Industries.

Except for an increased internal demand in Germany, owing to the new Government policy of subsidising shipbuilding and railway extensions and other steel-using schemes and ordering extra constructions in other lines at the expense of the State, there is no marked change in Continental steel trades. The Steel Cartel cannot control its members. There are threats of withdrawals. There is great confusion within and without the Cartel because of differences of opinion and interests. Changing tariffs and political policies, import quotas, uncertain currencies or exchanges, are far too baffling and too quick-changing for the international Cartel to be able to exercise authority over the various groups of its constituents. There is chaos in the Continental steel trade. Furthermore, the Belgians, French, and Germans have lost most of their business in what was long their best export market—Great Britain. In recent months, production has declined in France, Belgium, Luxemburg, and the Saar, Germany being the only Cartel country to show an increase, and that for the reason just mentioned. Output has increased slightly in Poland, Sweden, and Italy. In the United States the spurt inspired by the new trade revival scheme or talk has fizzled out. Production has dropped, and with higher wages and shorter hours the American industry will be more handicapped than ever.

American conditions are often misunderstood. American competition in the heavy and medium iron and steel trades has nearly ceased to count outside the United States and Canada, and, as mentioned above, it is being challenged in the Dominion by British manufacturers. Thirty-three years ago it was boldly asserted that America would "annex the world's export trade in steel." In 1901 a "Billion Dollar Steel Trust" was formed to bring every process of production, from raw ore mining to machining the finished goods, under a single management. It was declared that costs would be reduced, and that an enormous export business would be rapidly built up. American was then second in exports. She is now in a very weak fifth position in the international trade competition, with Canada as her only considerable export market, and it may be that British competition, plus Canada's own products, will cause the American manufacturers to lose most of their business in the British Dominion. Under trust management American costs have increased and not decreased as expected and predicted when the trust was formed. In the last few years pit iron has cost from 5s. to 15s. a ton more in America than in Britain ; steel bars have ranged from 15s. to 30s. a ton dearer in American than in our country ; and galvanised steel sheets have been from 30s. to nearly 60s. a ton dearer at the American works, far inland, than they have been quoted f.o.b. in England, Scotland, and Wales. When it is added that it costs about 100 per cent. more to carry American steel from the works overland to the leading stations in Canada than it costs to carry our steel to the St. Lawrence ports, and when, further, it is noted that our steel and products have a fiscal preference over American goods in Canada, the British chance in the Dominion market against American heavy goods will be appreciated. And it may be remarked that President Roosevelt's policy of higher wages and other costs will not assist American export trade. The big factor against America as an exporter of steel and related manufactures is high cost of transport, caused mainly by extremely long hauls for materials and products. Before the recent 10 per cent. advance in rail charges in the United States, the average transport cost on a ton of steel—cost of assembling raw materials and carrying the finished product to a port of shipment or a land boundary station—was 150 per cent. higher than the average all-in transport costs on a ton of British steel. Our short hauls for ore and fuel, iron, and finished steel, give us a transport cost advantage over all our competitors, even the Belgians. Our mines are near our furnaces and our furnaces and steel works are, in most cases, near shipping ports. A ton of steel can be carried even from Sheffield, in the middle of England, to Montreal for half the transport cost on a ton of American steel consigned to that Canadian city.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE VULNERABILITY OF ELECTRICAL POWER.

SIR,—Vested interests, political pull, and the apathy of the man-in-the-street, all combine to development of electrical power without due consideration of its limiting feature. None will deny to electricity its just fields of utility, its attractive cleanliness and convenience, or its almost indispensable service for underground traction, &c.; but on the salient feature of reliability it falls, and ever must fall, far short of perfection, since in its transmission lies its "Achilles heel," and in that department continuity may depend on such inconsiderable factors as the nesting of a crow (India), or the appetite of a starving rat, not to name ice, snow, flood, lightning, or other vagary of the weather.

With a view to compiling a rough record culled from the daily Press generally, not long since I commenced to collect "cuttings" reporting any failures of current that appeared in the London papers with the intention of submitting them at the expiration of six months. Seven weeks have, however, established a mean of one failure per week as under, and I am aware that I have omitted to collect two others reported :

November 22nd, 1933 :	Light failed at Hackney.
November 24th, 1933 :	Ditto, ditto, at Cardiff.
December 7th, 1933 :	Services Light failure, N.W. London.
December 20th 1933 :	"Grid" failure, involving heavy delay, Southern Railway.
January 8th, 1934 :	*Triple* failure reported, Herne Bay, St. John's Wood, and Wilts. and Berks. area.

It is no mild indictment, and one may well ask—Is this a means of transmitting energy suited to the essential services of a great nation which, in the present state of world politics, may yet be faced with another crisis in its history before many years have passed ?

Doubtless, behind the guarded language of the War Report, this fact has had all consideration, but "more millions" are now being asked for electrical development, if the lay Press reports correctly, and how are they to be

applied? Since we now have a long mileage of third rail main line conductor, would it be admissible to propose that mobile power-houses, arranged to turn their surplus power into the third rail, might prove a safer investment than extension of the central supply system with all its logically apparent weak points? I was permitted to make this suggestion several years ago, and recall that one expert in electrical traction endorsed its possibilities. Certainly it saves lengthy transmission, and unless there is some "snag," offers the benefit of pooled power resources for the total demands of the system, while retaining independent mobility for the locomotive unit—and these appear to offer no mean advantages.

Be this as it may, however, the intensified salesmanship of "grid" current for all purposes in and out of season has now become a face-saving effort to justify a major and very dubious experiment in a country not even possessing the original incentive of abundant water power, and so long as the good housewife deems it necessary to supplement her electric house lighting with a packet of candles—electric power is not, and never can be, a sound technical development beyond a certain point. May I submit with firm respect that that point has already been passed in this country? S. P. CHRISTIE.

London, S.W.7, January 8th.

MULTIPLE MARINE OIL ENGINES.

SIR,—Your correspondents on the above subject are suggesting transmission gear; one favours electrical transmission, the other gears or mechanical transmission.

But why not direct drive and cut out transmission gear, with its attendant losses, weight and expense?

I have before me a picture of Sir H. Segrave's speed boat "Miss England," and this shows a propeller running at 6500 revolutions per minute, so there is evidently no limit to the speed of propellers. Now high-speed propellers, in conjunction with high-speed engines, will further cut down the size and weight of the machinery.

I would suggest four high-speed propellers direct driven by lines of engines arranged tandem fashion, each engine unit consisting of six or eight cylinders and connected to the other units by suitable couplings and friction clutches.

These lines of engines could be added on to indefinitely, according to the power required. For starting and slow running the engine nearest the propeller would be first started, and then the other units brought into action, as required, by means of the friction clutches, but there need be no clutch between the first engine and the propeller shaft.

For reversing, a system of planet wheels could be used with a control lever giving three positions—ahead, neutral, and astern. The reverse gear and the thrust block could be embodied in one piece of machinery, thus making a solid job of it.

W. SUMNER.

Maidstone, January 13th.

"THE THIRD DIMENSION."

SIR,—"Dubious" in your issue of January 5th is surely over-pessimistic. All forms of movement involve "risk." The sea has its perils of rocks and storms; the railway those of collision and derailment; road transport suffers from skidding and collision; the walker may step on the banana skin.

Flying involves risks not perceptibly greater than those which other transportation suffers, although, as in the early days of motoring, air accidents are given undue prominence.

But, after all, the insurance companies are the best judges of this matter. Imperial Airways can now obtain insurance rates for travellers, which are as low as those charged for surface transport over the same distance.

Of the future, it is unwise to prophesy. What would our forefathers have said if we had suggested that ships would have been propelled by such combustible materials as coal and oil? Could they have conceived of our railway speeds? Would they not have laughed at prophecies which forecast the present speed and density of traffic on our roads? While the air, the sea, and the land have their tragedies, it is perhaps unwise to boast of conquest over Nature, but we need not unduly fear her powers; but we cannot doubt that the ingenuity and perseverance of that marvellous animal man will be ever equal to the calls made on him by increasingly complicated mechanism.

J. A. CHAMIER,
Air Commodore; Air League, Secretary-General.

London, W.1, January 12th.

RAILWAY COLLISIONS.

SIR,—In 1921 the Pullman Car Company, Ltd., modified their standard construction by adopting the use of steel underframes, and later embarked upon "all-steel" construction. Prior to 1921 Pullman cars in Great Britain were of all-timber construction, and it was believed that the use of timber resulted in quiet running. It has been found, however, that it is possible to construct "all-steel" cars at least as silent in running as wooden cars, by the fitting of carefully designed springing with india-rubber auxiliary springs.

I feel that your correspondent, Mr. A. E. Bennett, is incorrect in suggesting that passengers in steel carriages would probably fare worse in the event of a collision than if they occupied wooden carriages. The shock sustained by the passengers on impact would be identical with either construction, but in wooden carriages they would be endangered by the fractured and splintered wooden framing. The body framework in steel carriages is simple, and would generally deflect or cripple as a framework and not as a series of independent members. It is unlikely, therefore, that the passengers would be enveloped "in a mass of tangled and buckled steelwork." Photographs of collisions between trains of steel carriages in the U.S.A. show that the carriages do not tend to collapse in their structures, but are knocked out of line as a train, and it is usual in Pullman construction to build the end frames of the carriages as strong homogeneous steel castings, to guard against the crippling of the carriage bodies. American designers are assisted in this matter by being able to provide centre sills in the underframes of great strength, owing to the standardisation of automatic centre coupling.

It has at times been suggested that wooden framework is of value in cushioning the shock on collision. It is possible, however, by the provision of india-rubber or friction buffing springs to reproduce this effect in steel carriages.

The main causes of casualties in collisions have been the "telescoping" of the bodies, the fracture and collapse of wooden framing, and the ingition of escaping gas. The use of gas in railway carriages is rapidly becoming obsolete, and there is ample evidence to prove that the evils of "telescoping" and framework collapse can be removed by the use of correctly designed steel carriage stock. The use of welding in the assembly of steel carriages is now making rapid headway, and I suggest that this will be a further safeguard in preventing disintegration of framework in collisions.

S. R. DEVLIN.

Burton-on-Trent, January 14th.

SIXTY YEARS AGO.

WE have already referred in this note—see our issue of December 1st, 1933—to the collision between the C.G.T. liner "Ville du Havre," and the sailing ship "Loch Earn," whereby both vessels were sunk with the loss of 226 lives. The controversy which the disaster excited was considerable, and for several weeks after its occurrence our correspondence columns contained communications from shipbuilders, engineers, and others—including a letter from Captain Surmont, of the French ship—bearing on the accident and its lessons. The collision occurred in quiet and clear weather at 2 a.m. on November 22nd, 1873. The "Ville du Havre" was homeward bound from New York to Brest, and the "Loch Earn" was outward bound from Liverpool to New York. The ships sighted each other while they were still 3½ miles apart. It was fully understood by all concerned with the navigation of both vessels that by international convention it was the duty of the steamer to keep clear of the sailing ship. Nevertheless, the "Loch Earn," with all sails set, and proceeding at about 10 knots, collided with the "Ville du Havre" steaming at about 12 knots. The liner was struck amidships, and a rent over 16ft. long was torn in her hull. Water poured into her engine-room and stokehold, and ten minutes after the shock she sank. Of the crew, numbering 171, fifty-seven survived, while of the 135 passengers, twenty-three escaped with their lives. The "Loch Earn" herself sank shortly afterwards, but not before those on board, including some of the survivors from the liner, had been rescued by a passing ship. The French Court of Inquiry blamed the "Loch Earn" for the disaster. It accepted the rule that it was the duty of the steamer to keep clear of the sailing vessel, but it argued that the sailing vessel had failed to observe an equally binding succeeding rule of the International Code, namely, that while the steamer was taking steps to avoid a collision, it was the duty of the sailing ship to continue on her course. It was asserted that the "Loch Earn" did not leave the avoidance of the collision entirely to the "Ville du Havre," but altered her course in a manner which introduced confusion into the respective movements of the two vessels and made a collision inevitable. The British Court of Inquiry laid the blame entirely on the French liner. Leaving that aspect of the disaster aside, we turned in our issue of January 16th, 1874, to discuss the disquieting fact that it should be possible for a 1200-ton sailing ship so to damage an 8000-ton liner that the liner should sink in ten minutes. A close study convinced us that the liner, although she had recently been lengthened and converted from a paddle to a screw steamer, possessed no structural weakness sufficient to account for the effects of the collision. Further, with a reserve buoyancy of 10,000 tons, we failed to see why the flooding of the engine and boiler-rooms alone should lead to the sinking of the ship. The conclusion we reached was that other compartments must also have been flooded and, therefore, that no attempt had been made by the crew of the "Ville du Havre" to close the water-tight doors, or, if such an attempt had been made, it had failed to be effective. We argued strongly in favour of the development of some means whereby the water-tight doors of a ship could be quickly and certainly closed in an emergency. Many years were, however, to pass before such a system, operated by hydraulic power, as we now find on most liners, was brought to perfection and became generally adopted. Another outcome of the disaster was a revival of the suggestion made by Captain Maury in 1855, that special routes should be reserved for steamships crossing the Atlantic.

THE QUARTER'S SHIPBUILDING RETURNS.

THE statistics issued by Lloyd's Register of Shipping regarding merchant vessels under construction at the end of December last show that in Great Britain and Ireland there is an increase of 27,779 tons in the work in hand as compared with the low figures for the previous quarter, and also that the present total—331,541 tons—is 106,044 tons greater than the tonnage which was being built at the end of December, 1932. At the end of December the tonnage on which work was suspended amounted to 145,122 tons—about 139,000 tons of steamers and 6000 tons of motor ships. (NOTE.—These figures include a 73,000-ton steamer on which work is expected to be resumed almost immediately.) The total of the tonnage now on the stocks continues the steady increase which has been observable since the beginning of last year. About 71,000 tons—21 per cent. of the tonnage now being built in this country—is intended for registration abroad or for sale.

The tonnage now under construction abroad—425,736 tons—is about 27,000 tons less than the work which was in hand at the end of September, 1933, and is the lowest total recorded for abroad since June, 1909. Tonnage, included in the total in hand abroad, on which work has been suspended amounts only to 1465 tons of steamers and 25,653 tons of motor ships. The five leading countries abroad are:—Japan, 106,760 tons; France, 90,656 tons; Sweden, 64,640 tons; Holland, 40,540 tons; and Spain, 35,724 tons. The total tonnage under construction in the world amounts to 757,277 tons, of which 43·8 per cent. is being built in Great Britain and Ireland, and 56·2 per cent. abroad.

In Great Britain and Ireland 74,701 tons were commenced during the last three months, showing an increase of 35,031 tons over the corresponding total for the September quarter. During the quarter ended December, 1933, 65,274 tons were launched in Great Britain and Ireland, an increase of 23,197 tons as compared with the September quarter. Similar figures for abroad are 69,960 tons commenced, and 109,664 tons launched, showing a decrease, as compared with the previous quarter, of 1142 tons in the tonnage commenced and an increase of 19,431 tons in the tonnage launched.

Oil tankers under construction in the world amount to 19 vessels of 117,608 tons, of which 5 vessels of 31,026 tons are being built in Great Britain and Ireland, 6 vessels of 41,100 tons in Sweden, 2 of 19,200 tons in Japan, 5 of 18,212 tons in Spain, and 1 of 8070 tons in Denmark. Of the 331,541 tons under construction in Great Britain and Ireland at the end of December, 112,276 tons consisted of motor ships, while at the same date the motor ship tonnage being constructed abroad, 305,978 tons, was 188,490 tons in excess of that of the steamers. The vessels being built in the world at the end of December include 1 steamer and 8 motor ships of between 8000 and 10,000 tons each, 7 motor ships of between 10,000 and 20,000 tons, and 2 steamers of 73,000 tons and 68,000 tons respectively, and no motor ships of 20,000 tons and upwards.

The table respecting marine engines shows that the horse-power of steam engines now being built or being fitted on board amounts to about 552,000 H.P.; these figures include 29 sets of turbine engines of about 466,000 shaft horse-power. The horse-power of the steam reciprocating engines, about 86,000 H.P., amounts to 7·3 per cent. of the total horse-power of marine engines now being built in the world. The figures for oil engines aggregate approximately 621,000 H.P.

Of the reduced amount of shipbuilding in hand throughout the world, the tonnage being built under the inspection of Lloyd's Register at the end of December amounts to 557,032 tons. Of this total, 319,322 tons, representing more than 96 per cent. of the tonnage being built there, is under construction in Great Britain and Ireland; while of the tonnage being built abroad, 237,710 tons, or nearly 56 per cent. of the total, is being constructed under the inspection of Lloyd's Register.

PUMPING MACHINERY.

WE do not know if the science museums of other lands issue handbooks of their exhibits as good as those issued by our own Science Museum, but we do know that they could not issue better books of the kind. From the first they have been really good, and they seem to improve as time goes on and the number of volumes increases. The latest example, which is Part II. of Pumping Machinery, is a case in point. It presents admirable brief descriptions of the exhibits and follows the very useful practice of giving one or two bibliographical references. The plates of illustrations are distributed through the volume instead of being collected together at the end, as in some of the early volumes. We are not sure which is the better plan. There is a peculiar pleasure in turning over the pages of photographs—like an album of old friends and relatives—which one misses with the modern arrangement. May we add, too, an expression of regret that the Museum has not more money at its disposal so that it might give more pictures. As there are XXIII. plates in this volume, most of them illustrating more than one object, this desire is palpably greedy and not Oliver Twistian, but we believe we shall not be alone in expressing it. Part I. of "Pumping Machinery" was historical; with it and the present part the happy possessor has a complete history of pumps and pumping from the earliest to the latest days for six shillings.

EDUCATIONAL INTELLIGENCE.

UNIVERSITY OF LONDON.—A course of four lectures on "Explosives and their Use in Breaking Ground" will be given in the Mining Lecture Theatre, Royal School of Mines, Prince Consort-road, S.W.7, by Professor J. A. S. Ritson, D.S.O., M.C., B.Sc., M.I. Min. E., Professor of Mining in the University of Leeds, at 5.30 p.m. on February 26th, 27th, 28th, and March 1st, 1934. At the first lecture the chair will be taken by Professor S. J. Truscott, D.Sc., A.R.S.M., M.I.M.M., F.G.S., Professor of Mining in the University. The lectures, which will be illustrated with lantern slides, are addressed to students of the University and to others interested in the subject. Admission free, without ticket.

THE F.B.I.—At a meeting of the Grand Council of the Federation of British Industries, held on January 10th, Lord Herbert Scott was nominated to succeed Sir George Macdonogh as President of the Federation for the coming year. Subject to confirmation, Lord Herbert Scott will enter upon his new duties early in April. He is now a director of Rolls-Royce, Ltd., Cellulose Acetate Silk Company, Ltd., Tilbury Contracting and Dredging Company, Ltd., United Glass Bottle Manufacturers, Ltd., and the Sun Insurance Office, Ltd.

The Physical Society's Exhibition.

No. II.

(*Concluded from page* 38, *January* 12*th*.)

TWO electric tele-transmission systems, both suitable for remote indicating, recording, and intergrating were exhibited by the Drayton Regulator and Instrument Company, Ltd., of West Drayton, Middlesex. The arrangement shown in Fig. 13 is known as the variable split potential transmission system, and that in Fig. 14 the split potential balancing system. Both are operated with A.C., and while the former is independent of voltage and periodicity variations, but requires adjustment for line resistance, the latter is also independent of line resistance. The primary impulse can be taken from any pressure, temperature, liquid level, or flow

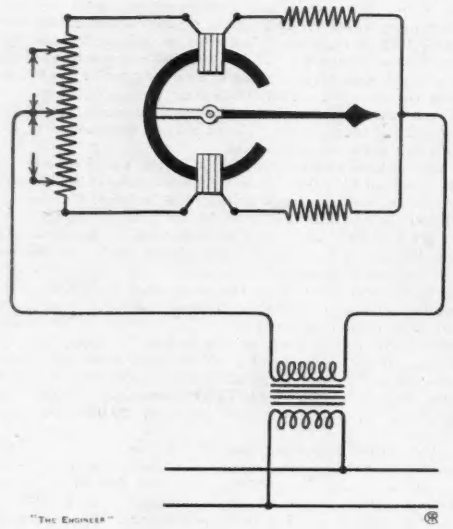


FIG. 13—SPLIT POTENTIAL TELE-TRANSMISSION SYSTEM

indicating or recording instrument, or the impulse may be a direct mechanical movement.

The indicating instrument shown in Fig. 13 consists of two fixed coils which encircle a split iron ring. The coils form part of two branch circuits, each of which also comprises part of the transmitting resistance determined by the position of the brush indicated on the left of the diagram. Thus the current flowing in the branch circuits depends on the position of the transmitter brush, which is determined by the position of the originating instrument which actuates it. The position taken up by the

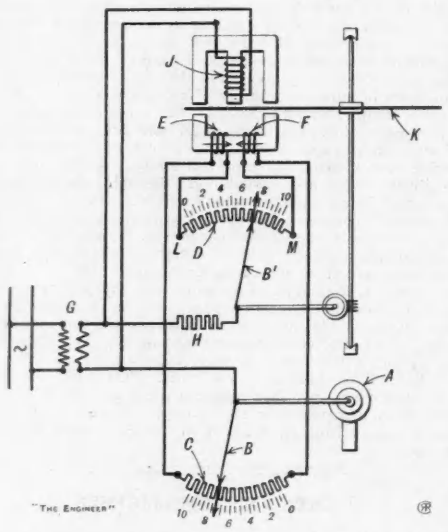


FIG. 14—BALANCING TELE-TRANSMISSION SYSTEM

moving iron ring and the pointer connected to it corresponds to the proportion of the currents flowing in the two branch circuits, and therefore to the brush position.

In the case of the balancing system shown in Fig. 14, the primary instrument A operates the sliding contact B over the variable resistance C, and a similar resistance D is incorporated in the receiving instrument which is a modified form of watt-hour meter, with two coils E and F connected in circuit with the resistances C and D in the manner shown, the circuit being supplied with current by a transformer G, through a resistance H. The voltage coil J of the meter motor is connected across the transformer. The balancing resistance D is operated by the aluminium motor disc K, the direction of rotation depending on the currents in the coils E F. If the currents at L and M are equal, the ampère turns of the coils E and F will be equal and with the coils connected as shown the motor will stop. But if one current is larger or smaller than the other the disc will turn to the right or left, with a velocity proportional to the difference. The disc will therefore come to rest when the ohmic resistances in the two branches are equal, and will rotate to the right or left when they are unequal, and the disc K will always have a tendency to adjust the slider B^1 so as to equalise the two branch resistances and to bring itself to rest. When the disc is stationary the brush on the balancing resistance D and the pointer attached to it takes up a position on the scale corresponding to the

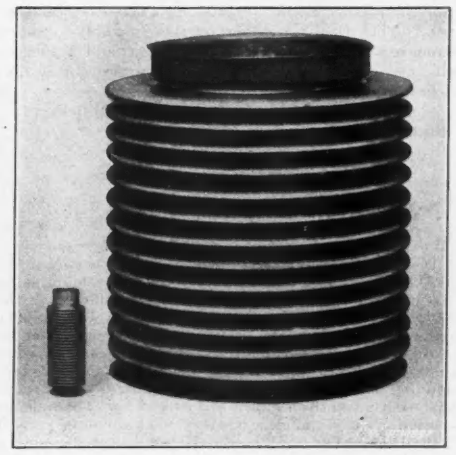


FIG. 15—HYDRAULICALLY FORMED BELLOWS

position of the pointer on the originating instrument, and the position is independent of the resistance of the connecting wires, as well as the voltage and periodicity.

The Drayton Regulator and Instrument Company was also showing for the first time a collection of hydraulically produced flexible metallic bellows, as employed in many of its instruments. These bellows (shown in Fig. 15), are made by placing a metal tube in a die and by applying a hydraulic pressure, so that they are subjected to a test during the forming process.

Among the exhibits of the General Electric Research Laboratories was an electromagnetic fatigue testing apparatus shown diagrammatically in Fig. 16. The specimen under test is supported at two nodes, and is vibrated at its natural frequency by electromagnets. A simple form of gas-filled relay inverter

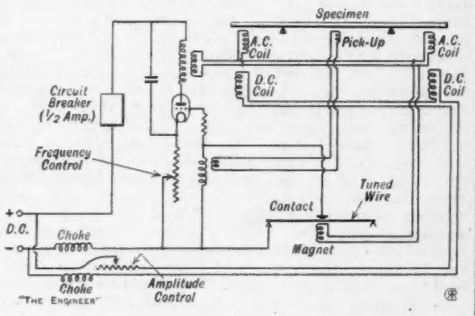


FIG. 16—FATIGUE TESTING APPARATUS

circuit supplies the A.C. coils, and an electromagnet under the centre of the bar automatically maintains the frequency at a value corresponding to the natural frequency of the specimen. But as soon as the specimen begins to crack, a fall in the natural frequency occurs and this causes a tuned wire to vibrate and to close a contact which earths the grid of the valve, and so cuts off the A.C. supply. A recording drum with a pen which can be set to the appropriate value of the stress, is driven by a geared synchronous motor at a logarithmically decreasing speed, and when the bar fails the pen is lifted, so that a point on the endurance curve is directly plotted. By using several testers recording on the same drum, a complete endurance curve covering up to 10,000,000 cycles can be completed in ten hours.

A photometer for the demonstration or rough testing of the polar distribution of light from lamps or lighting fittings was another G.E.C. exhibit. A voltaic photo-cell is rotatable round the unit under test and produces a deflection on a mirror galvanometer. The spot of the galvanometer moves over a sheet of polar curve paper, which is rotated automatically by the rotation of the arm bearing the photo-cell. By following the track of the spot on the paper with a pencil the polar curve of light distribution is obtained.

A model was shown for investigation of the principle of the Chance coal washer, in which coal is separated from shale by the use of a sand-water mixture, which floats the coal and allows the shale to sink. The model consists of a vertical cylinder

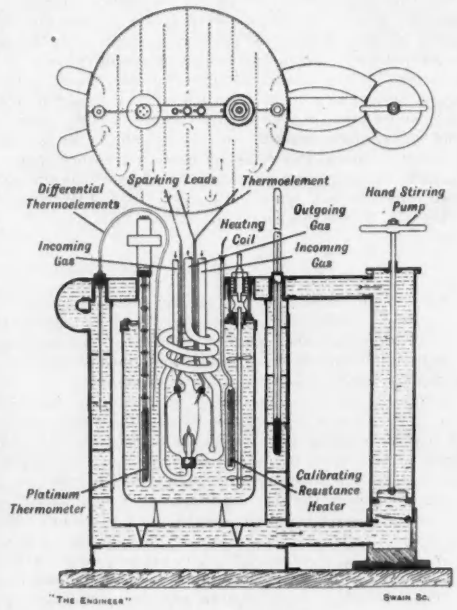


FIG. 17—CALORIMETER

partially filled with sand, through which an upward current of water is passed, so as to maintain the sand in suspension. The sand-water mixture so formed behaves as a high-density liquid, and the density is readily controlled by the water flow. It was shown that by a suitable choice of sand, equivalent densities ranging from 1·15 to 1·5 are easily attainable without an excessive flow of water.

Apparatus for measuring heats of combustion of gases was shown by Mr. J. H. Awbery and Dr. E. Griffiths, in the section set aside for National Physical Laboratory exhibits. The calorimeter—Fig. 17—and accessory apparatus have been used for measuring the heats of reaction between carbon monoxide and oxygen and between carbon monoxide and nitrous oxide, both constants being required in research work

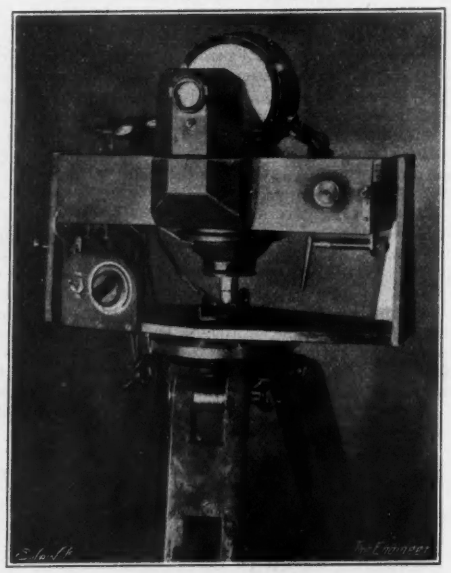


FIG. 18—GLAREMETER

on internal combustion engines. A jet of one gas is burnt in an atmosphere of the other in a "Pyrex" combustion vessel, the products of combustion passing through U tubes containing an absorbant for carbon dioxide used to analyse the products and to deduce the amount of gas burnt. The "Pyrex" vessel is immersed in a brass calorimeter with a lid having a coned joint.

An "umbrella" on the stirrer shaft just outside the lid dips into oil and gives a water-tight seal. A hand-operated pump circulates water through the lid, sides, and top and bottom of the double walled jacket, in which the calorimeter stands, and by an inter-

mittently operated switch a heating coil on the surface is made to maintain the temperature of the jacket close to that of the calorimeter. The correct temperature between the two is maintained throughout the experiment, the temperature of the calorimeter rising about 4 deg., measured by means of a resistance thermometer. A heating coil immersed in the calorimeter serves for calibrating the apparatus by noting during an independent experiment the amount of energy dissipated.

Dr. Griffiths also exhibited hot plate and guard ring apparatus for thermal conductively measurements and a voltage control device for use with the apparatus. The resistors of both the hot plate and guard ring are wound on one sheet of insulating material, and the hot plate area is partially isolated from the guard ring area by a series of perforations, so as to obtain the maximum thermal resistance between the two. Aluminium plates are attached to the two faces with thermo-elements laid in grooves and riveted. The hot plates are inserted midway between two parallel cold plates and the material under test is packed in between them.

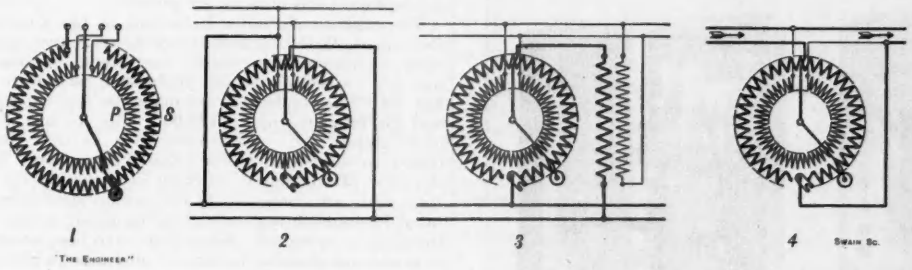


FIG. 19—VOLTAGE REGULATOR DIAGRAMS

The glaremeter—Fig. 18—was exhibited on the National Physical Laboratory's stand by Dr. W. S. Stiles and Mr. B. H. Crawford. The object of the instrument is to determine quantitatively the reduction in the visibility of objects, owing to the presence of glaring sources of light in the field of view. What is actually measured is the smallest difference of brightness between a small test spot and its immediate surroundings, which the eye can perceive when looking in any assigned direction under given conditions of lighting. If glaring lights are present, the least perceptible brightness difference has a higher value than when the glare sources are screened from the eye of the observer, and the ratio of the measured values for the two cases provides a measure of the degree of glare. In the instrument under consideration a more complicated procedure is adopted. Arrangements are made for the observer to view the test spot, adjusted to be just visible for the lighting conditions under test, against an extended field of uniform brightness formed in the instrument by means of a whitened sphere. The intensity of this uniform field brightness can be varied until the test spot is again just visible, and in this way the so-called "equivalent uniform field brightness β" is determined.

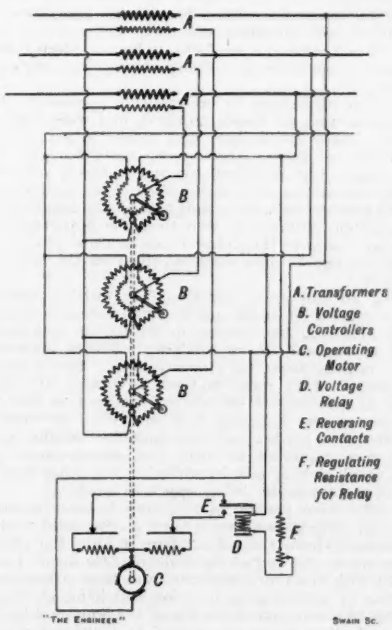


FIG. 20—AUTOMATIC VOLTAGE REGULATOR

The principle of the instrument is simple. A beam of light, forming a virtual image of the test spot at infinity, is reflected into the observer's eye with the aid of a plain glass mirror inclined at 45 deg. to the vertical, through which the observer views the external field. Thus the observer sees the test spot formed at any desired point in the field. The test spot is exposed for an interval of about 0·1 sec. by pressing a lever, which also operates an absorbing wedge in the test spot beam, so that the intensity of the flash is increased or decreased by a given proportion at each exposure. When the critical test spot intensity has been found, the whitened sphere is swung into position, so that it blocks out the external field and exposes instead a uniform brightness. By a mechanical device the lever is then disconnected from the test spot wedge, and is linked with the wedge controlling the sphere brightness. At each exposure of the test spot, the sphere brightness is increased or decreased in a given proportion and the equivalent uniform field brightness can be determined without difficulty.

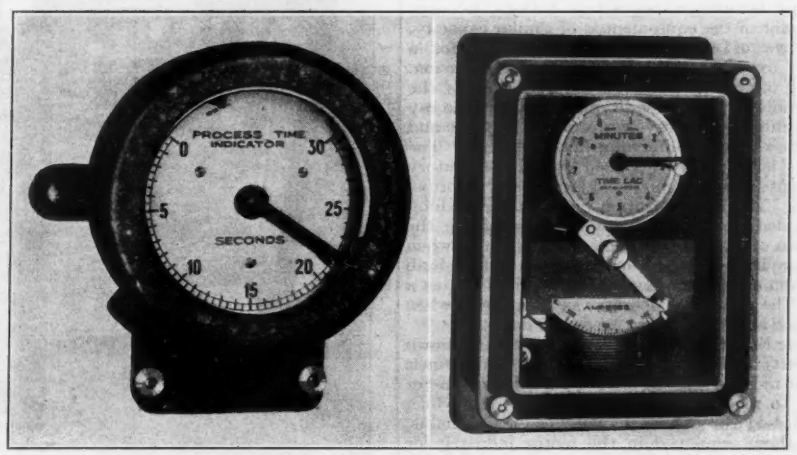
An interesting voltage regulator suitable for outputs up to 7·5 kVA, was one of the exhibits of Isenthal and Co., Ltd., of Duncan Works, Victoria-road, North Acton, W.3. The apparatus consists of a ring-wound transformer, as shown at (1), Fig. 19, with a carbon collector sliding or rolling over the secondary winding, from which the insulation is partially removed. The collector can, of course, be moved by hand or automatically by means of a small electric motor. It is carried by a spur wheel, which in the case of automatic operation is suitably coupled to the motor. The primary winding is connected to the supply, and movement of the collector gives a secondary voltage variation from zero to a maximum. If, however, the two ends of the secondary winding are connected alternatively to the middle of the primary winding by a change-over switch indicated at (2), Fig. 19, the regulating range can be doubled. If the primary pressure be 110 volts, and the secondary pressure be 55 volts, then without the change-over switch the regulating range will be 0–55 volts, but with the switch connecting the primary with the secondary, it may be increased to 0–110 volts. If it is essential that the primary should be insulated from the secondary, the same range may be obtained with the arrangement shown at (3) in Fig. 19. By choosing some other tapping point on the regulating transformer, or by changing the transformation ratio of the intermediate transformer, the regulating range may be made to begin at any desired low voltage instead of at zero and then extend towards higher values.

This double utilisation of the secondary winding assumes its most simple form when the tapping point coincides with the end of the primary winding, as shown at (4) in Fig. 19. By moving the current collector the amount of secondary winding connected in series with the mains is varied, and the regulator is made to buck or boost, according to the position of the change-over switch. When all the secondary winding is utilised the magnetic leakage is very small, but as the amount of secondary winding utilised is decreased, it increases considerably. By the use of a third compensating winding, however, excessive leakage is eliminated. The connections for a three-phase automatically controlled regulator is shown in Fig. 20, which is self-explanatory.

Many useful electrical measuring instruments were shown by Ferranti, Ltd., of Hollinwood. Among the new examples were two electrostatic voltmeters, one with a range of 0–150 volts, with a scale reading in 5-volt divisions from 20 volts upwards, and the other (shown in Fig. 23), with a scale of 0–12 kilovolts. The latter works in conjunction with a fixed condenser used as a potentiometer, and permits of the direct measurement of very high A.C. voltages. The condenser and instrument are fitted in the same wooden case. Owing to the delicate construction of the 0–150 volt electrostatic voltmeter, it is less robust than the higher range instruments, and it is, consequently, spring-borne in a substantial cast iron case. Magnetic damping brings the pointer to rest within a few seconds. A new moving coil A.C./D.C. instrument exhibited has a full-scale reading of 5 volts A.C. and 50 millivolts D.C., and as both ranges have a resistance of 1000 ohms per volt, additional ranges of 0–1 milliampères A.C. and D.C. can be obtained, whilst from these four ranges any number of A.C. and D.C. ranges can be secured by the use of external shunts and resistances.

Limitations of space will not allow us to describe all the new Ferranti relays. Besides a new overload and leakage relay, an auxiliary relay and a control relay, there was an A.C. reverse relay with time lag. Compensation for fall in voltage is included in the latter, and considerable voltage drop does not increase the operating current. Correct operation is said to be secured in the event of the voltage falling to 1 per cent. of the full value. The new overload and leakage triple-pole relay has the two outer poles arranged for over-current protection, and the centre pole for earth leakage protection. It is of the induction, spring-controlled type, with inverse and definite minimum time lag. Outstanding features are excellent torque, low volt-ampère consumption, and exceptionally effective damping magnets which prevent overswing. The operating values and the time lag are adjusted separately, and the time

FIG. 23—ELECTROSTATIC VOLTMETER



FIGS. 21 AND 22—PROCESS TIMER AND MAXIMUM DEMAND "TELL TALE"

characteristic is reproduced on the scale. An electrically operated flag indicator on each pole gives indication of operation, and also closes reinforcing contacts in parallel with the main contacts. Normally, the relay is self-resetting, but hand reset can be fitted when required.

The process timer, shown in Fig. 21, was one of the exhibits of Everett Edgcumbe and Co., Ltd., of Colindale Works, Hendon, N.W.9. These instruments, operated by a Synclock Warren motor, are made in many forms, according to the use to which they are to be put. The arm of the instrument illustrated is set to some particular time, such as 22 sec., and the instrument starts operating as soon as the main switch is closed. At the expiration

of 22 sec., a contact is automatically closed, and either gives a visible or audible signal, or stops a given process by switching off the main current, when the timer resets itself in order to operate again. Another model sounds an alarm when a circuit has been closed for a given number of short intervals, and the alarm continues until the main circuit is broken. The instrument is then reset, as in the case of the process time illustrated.

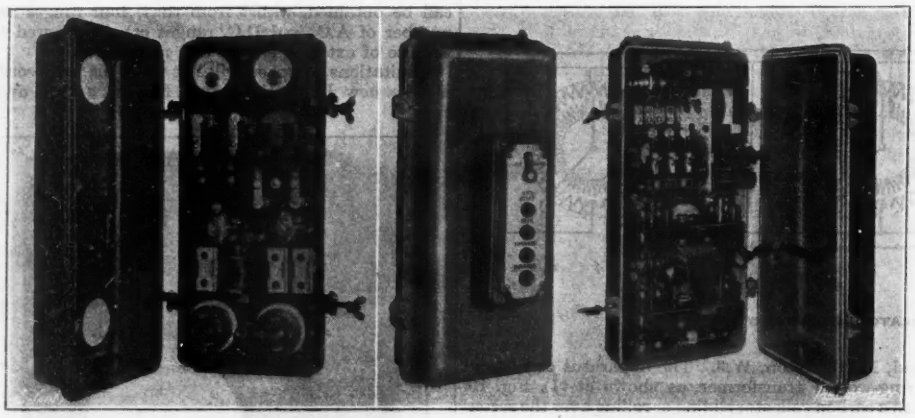
The maximum demand "tell tale," Fig. 22, was another of the many Everett Edgcumbe exhibits. When an industrial consumer of electricity is charged for energy according to the maximum load during the quarter, it is desirable that he should be warned if any additional load occurs before the allotted period of, say, twenty minutes, has elapsed, and the instrument under consideration has been designed for that purpose. It consists of an induction ammeter or wattmeter movement—according to whether the charge is based on kilovolt ampères, kilowatts, or other quantity—with an index that can be set to any desired load. Directly this load is exceeded, an adjustable timing device is started, and if the overload continues for the period for which the timing device has been set, a visible or audible signal is given. As a rule, the timing device is set for ten or fifteen minutes less than the time upon which the charge is based, so that the consumer has ample opportunity to reduce his load before the supply authorities' maximum demand meter imposes a penalty. The instrument also has a scale which enables the instantaneous value of the load to be read at any time.

Professor J. K. Catterson Smith exhibited a 7-kW three-phase glass bulb rectifier, with grid control, for the purpose of showing the action of the grids as a means of varying the D.C. output pressure between zero and full voltage, and for demonstrating the operation of the apparatus as an inverter. The set forms one unit of the new equipment recently manufactured by the Hewittic Electric Company, Ltd., of Walton-on-Thames, for installation in the electrical engineering laboratories at King's College, London. Another unit of the equipment is of similar capacity, but consists of a six-phase bulb arranged for a variety of experiments and especially for inversion. Measuring instruments showed the behaviour of the circuits under different conditions and a cathode ray oscillograph gave the wave form of the voltages and currents flowing with different grid adjustments. The apparatus is primarily designed to suit laboratory requirements, and is a good deal larger than a normal 7-kW set. The demonstration given at the Exhibition included the effect of gradually increasing the retardation of the ignition angle up to 90 deg., when the average D.C. voltage dropped to zero and the bulb became non-conducting and consequently acted as a switch. The apparatus operates as an inverter when the ignition angle is made to exceed 90 deg.

No fewer than thirteen new instruments were shown by Negretti and Zambra, of 38, Holborn-viaduct. One of the most interesting is a recording thermometer designed to meet the demand for a recorder which can be passed through ovens with conveyor chains, such as those employed in the motor industry for stoving car wings, &c. The recording mechanism is mounted in a special insulated aluminium, chromium-plated case, which permits the recorder clock, chart and ink from attaining too high a temperature during the passage of the instrument through the oven. A short length of flexible capillary enables the sensitive bulb to be placed close to an article being stoved. The instrument operates on the well-known mercury expansion principle.

New types of portable multi-range "Tong-Test" ammeters to take cables or conductors up to 4in. diameter and suitable for use in link disconnecting boxes, were shown by Crompton Parkinson, of Chelmsford. A hinged mirror is provided to facilitate readings when the instruments are to be employed below pavement level. The instruments are suitable for use on both A.C. and D.C., and will give readings from 10 ampères upwards. The new mechanical power factor demonstrator described in our last issue was also shown. Other exhibits were a transmitter and indicator of the ratiometer type for remote indication, and a portable dynamometer wattmeter for use in conjunction with a small portable current transformer to give indications with currents from 0·05 up to 200 ampères at 150, 300, and 600 volts.

An automatic emergency lighting change-over and battery charging switch—illustrated in Fig. 24—was shown, among other things, by the Igranic Electric Company, Ltd., of 147, Queen Victoria-street, E.C.4. It automatically switches on a reserve battery when the main supply fails and causes the battery to be recharged at full charging current after use. Additional switches enable the reserve battery to be switched on by hand for test purposes or for simultaneous use with the main supply. They also enable the battery to be put on charge independently of the automatic battery relay. The control panel comprises a D.P. main switch and D.P. fuses, a battery charging contactor and relay, an emergency supply contactor, a hand operated emergency supply switch, a push button for manual operation of the battery charging contactor, two signal lamps to indicate "main supply on" and "battery on," a spring-controlled moving iron ammeter and a voltmeter, and a single-pole control circuit fuse. Visual indication of the operation of the controller is made possible by coloured windows over the signal lamps. The voltage reducing resistance for charging the battery is a separate unit housed in a wall fixing enclosure.



FIGS. 24 AND 25—EMERGENCY LIGHTING SWITCH AND MOTOR STARTER

The Igranic "adjustable time alternate acting starter" shown in Fig. 25 provides fully automatic time-regulated control for all motor-driven machines used for processes or movements which need positive time regulation of an individual reversing or alternate cycle or a continuous sequence of cycles. It incorporates an improved eddy current motor driven drum type timing device capable of fine setting and exact calibration. The drum mechanism is energised by a relay and serves to actuate heavy silver contacts which control in turn the control coil circuits of the main alternate acting or reversing contactors.

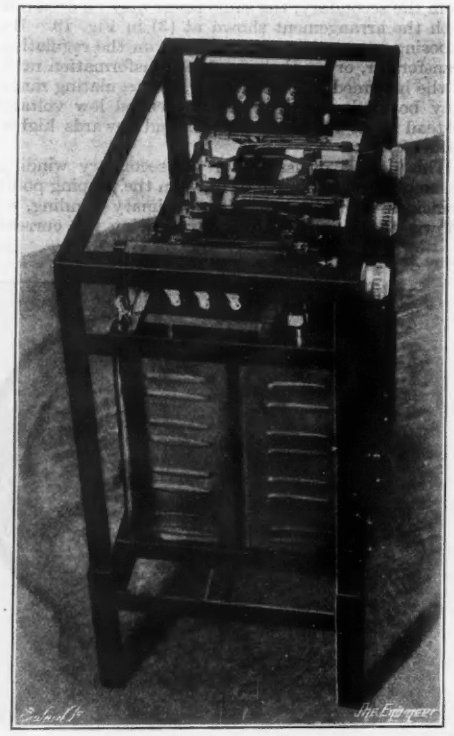


FIG. 26—CONDENSER FOR POWER FACTOR CORRECTION

The apparatus will work fully automatically or may be controlled by push buttons mounted on the controller door or at a number of conveniently situated control points. The associated machine can be automatically controlled as follows:—(*a*) Driven in one direction of rotation for any length of time adjustable between five and fifty minutes; (*b*) Stopped for any period adjustable between two and thirty seconds at five minutes' running time rising to twenty seconds, and 300 seconds at fifty minutes' running time; (*c*) Started in the reverse direction to run for any length of time adjustable between five and fifty minutes; and (*d*) stopped as in the case of (*b*) before recommencing to run as in case (*a*). Alternative mechanism gives running times in each direction adjustable from one to ten minutes. Both types will complete a cycle or any part of a cycle when the appropriate push buttons are pressed.

The exhibits of Philips Industrial, of 145, Charing Cross-road, W.C.2, consisted mainly of X-ray apparatus, photo-electric cells, barretters, rectifiers, mercury switches, and oil condensers, as shown in Fig. 26. The condensers are made for any capacity and for pressures up to 120,000 volts for use with oscillographs, &c. Condensers such as that illustrated are supplied for power factor correction. The elements of condensers working at pressures up to 1000 volts are composed of aluminium sheets separated by multiple layers of thin rag paper wound in the form of cylinders. After they have been treated in a vacuum chamber to remove all traces of air and moisture they are immersed in a pure hydrocarbon oil, which ensures permanent insulation. The cases in which the elements are mounted are designed to ensure that the condenser temperature does not exceed the room temperature by more than 18 deg. Fah. The dielectric losses are said to be very low.

Gidea Park and Shenfield Widening.

A WIDENING from Romford to Romford Factory Junction, completed in 1901, provided four continuous lines of way for the Colchester main line from Liverpool-street up to the latter point, a distance of 14 miles 10 chains. By the opening, on January 1st, of two additional lines for a further 6 miles 30 chains, these facilities have now been provided up to and including Shenfield. The widening is on the down side; the existing roads have become the through lines, and the new the local lines. The three intermediate stations at Harold Wood, Brentwood, and Shenfield retain the existing platforms for what is now the up through line; the former down platform serves, as an island platform, the down through and the up local, and there are new platforms for the down local. Some of the platforms have been lengthened, and those at Brentwood and Shenfield are each 600ft. long; the Harold Wood platforms are 520ft. in length. New station buildings, of an attractive design, have been erected as required.

Extensive alterations to bridges were necessary. Two overbridges were no longer required, and were removed entirely; three overbridges were reconstructed and the abutments of three others were underpinned. Ten underbridges were reconstructed and widened, and three entirely new bridges were built. Four of the underbridges and two overbridges were rebuilt to meet the requirements of the public authorities, who took the opportunity to widen and improve the public roads at these points. In all, twenty-two bridges were involved in the widening operations.

Owing to the great depth of the cutting between Brentwood and Shenfield, and to avoid extensive excavation in widening the cutting owing to the treacherous nature of the soil, heavy retaining walls on both sides of the railway have been constructed. These have a total length of 2¼ miles and are in places 20ft. high. The total quantity of excavation removed in the construction of the widening and new work amounts to 548,000 cubic yards; of this quantity 367,000 cubic yards were deposited to form new embankments and filling to platforms, and in widening the approaches to bridges, the remainder being tipped to spoil.

An interesting feature of the work is that the down local line, after it has passed through Shenfield Station, is continued, from the point where it joins the original double line at the end of the widening, for about 1 mile, parallel with the Colchester line, and then passes under that line by a burrowing junction and joins, at mileage 21 miles 30 chains, the down line of the Southend branch. That will allow trains to proceed to Southend without interfering with those running on the Colchester main line.

All four lines between Gidea Park and beyond Shenfield have been equipped with automatic signals of the colour-light type, which have allowed the box at Harold Wood, one of the two at Brentwood, and an intermediate box known as Ingrave, to be dispensed with.

The contractors for the general work, including earthworks, bridges, platforms, retaining walls, &c., were Sir Robert McAlpine and Sons, Ltd. The whole, including the signalling, has been carried out to the instructions and designs of Mr. C. J. Brown, engineer, Southern Area, L. and N.E.R. The works have been under the immediate supervision of Mr. R. J. M. Inglis, assistant engineer, construction, whilst the signalling has been carried out by the railway company's own forces under Mr. F. Downes, signal and telegraph engineer. The automatic signals were supplied by the General Railway Signal Company, and the train describers and certain other signal equipment by the Siemens and General Electric Railway Signal Company. The mechanical locking frame of 130 levers at Shenfield was provided by the Railway Signal Company.

A NEW sugar factory, which covers an area of 30 acres, has been started at Kolkapur, India.

Railway and Road Matters.

FURTHER appointments by the London Passenger Transport Board have now been made, and included in them is that of Mr. J. H. Millen, as Chief Electrical Engineer.

THE Liverpool tramway accident of January 3rd, wherein two persons lost their lives, was inquired into, on behalf of the Ministry of Transport, by Lieut.-Colonel Anderson on Wednesday, the 10th instant.

DURING a dense fog on Tuesday, January 9th, a London and North-Eastern passenger train ran into one belonging to the Great Western at Northolt Junction. There was a little telescoping of the Great Western coaches, but no serious personal injuries. This station is on the G.W. and Great Central Joint Line, and is operated by the former company.

THE express newspaper train recently instituted by the L.M.S. Railway between London and Heysham, leaving Euston at 7.30 p.m. on Saturday nights only, has been altered to call additionally at Warrington. The train, which does not convey passengers, is now scheduled to cover the 182 miles from Euston to Warrington in 191 minutes, at an average start-to-stop speed of 57·1 m.p.h.

MEETINGS between representatives of the railway companies and of the men's unions, as to an amended conciliation scheme, continue to be held. It is now generally believed that the companies propose that the National Wages Board shall consist entirely of independent members, instead of four representatives of the companies, four from the unions, four from "users of the railway," and an independent chairman.

THE present station at Southampton West consists of an up and a down main line and a bay line on the down side; the station buildings are on the up side. Work has now been started on a scheme, to cost £177,000, which will provide four through lines and retain the down bay line. Additional station buildings will be erected on the down side. A feature of the work will be the abolition of the public road level crossing at the London end of the station.

IT is reported that the Great Western is to fit speedometers to 100 locomotives. It may be recalled, in this connection, that Colonel Mount recommended the provision of speed indicators as a result of the Carlisle derailment of January 3rd, 1931. That officer remarked in his report on that occasion that he understood from Mr. H. N. Gresley that the fitting of indicators on the Edinburgh–Aberdeen engine of the L. and N.E.R. was then in hand.

A SERIES of seven handy pocket-size booklets giving tide tables, depth of water, phases of the moon, a map of the port, and other general information in respect of the principal L.M.S. railway ports, has been issued by the company for 1934. Copies are obtainable from the following ports:—Garston, Lancs., Barrow-in-Furness, Heysham Harbour, Fleetwood, Goole, Grangemouth, Ayr and Troon, or from the chief commercial manager, Euston Station, or the commercial manager, Central Station, Glasgow.

THE Ministry of Transport railway statistics for October last show that, compared with the corresponding period of 1932, the number of passenger journeys increased by 1·5 per cent., but the receipts from passengers dropped by 2·2 per cent. The tonnage of freight increased, however, by 6·2 per cent., and freight receipts by 7·6 per cent., with a rise of 3·5 per cent. in the train mileage. It is gratifying to note that the average train load rose from 121¾ to 123¾ tons, and the net ton-miles per engine-hour from 450 to 458¼.

DURING the last two years 2000 men have been discharged at Crewe Works. An intimation was, however, made on January 3rd, that a large number are to be reinstated—it is believed about 500. Seventy of the new engines that form part of the company's new works programme are to be constructed at Crewe, and thirty engines are to be rebuilt or repaired weekly. There are now 6000 men employed at Crewe, in contrast to 10,000 before the war. Part of that reduction has been caused by the reorganisation of the works.

THE collision of December 6th in the automatically signalled area near Alne, L. and N.E.R., was inquired into by Lieut.-Colonel Woodhouse. As at the Three Bridges, Southern Railway, collision of January 28th of last year, the driver stood at an automatic signal for the period prescribed in the stop-and-proceed rule, but did not then proceed with the caution the rule asks for. Colonel Woodhouse, during his inquiry, observed that the Ministry of Transport was rather in the dark whether the one-minute rule came into operation rarely or often, and it was therefore taking a return for three months.

THE Shropshire and Montgomeryshire Railway was, when authorised in 1862, intended, along with other lines, such as the East and West Junction Railway, to be part of a main line between London and Porthdinllyn, on the Cambrian Coast, that was to be a route to Ireland and rival that through Chester and Holyhead. None of the participating railways became anything more than a minor line, and the Shropshire and Montgomeryshire was no exception until the late Colonel H. F. Stephens rebuilt it, under a Light Railway Order, in 1911. Passenger traffic has now, however, been withdrawn owing to road competition.

IT is announced that before the end of the year 165 new oil units will be put into operation, bringing the total of such motor trains in service on the German State Railways up to nearly 250. Of the new units in course of construction, 150 are four-axle and 15 two-axle motor trains, designed for branch line and local stopping services. Three express motor trains for main line working are to be built, and two new models of the streamlined "Flying Hamburger" have been ordered for service between Berlin and Leipzig, and Berlin and Cologne. Experiments are now in progress, it is stated, for increasing for short periods the 410 H.P. developed by each of the two "Flying Hamburger" engines up to 600 H.P. by a new process of supercharging.

Notes and Memoranda.

THE construction of the Atchafalaya River bridge in America involved the sinking of one of the piers to what is claimed to be an unprecedented depth, 176ft. 6in. The bridge comprises three 600ft. spans, which were floated into place.

FROM the annual statistical report of new companies registered in England, issued by Jordan and Sons, it appears that some 620 engineering firms were registered during 1933 with a total capital of £4,747,000, and 499 electricity, gas, and water companies were registered with a total capital of £1,822,000.

A NEW iron with high abrasion resisting properties has been developed by the Robins Conveying Belt Company, New York, and called Super Manga Iron. It contains about 4·5 per cent. of nickel and about 1·5 per cent. of chromium. The structure is martensitic, and the chilled surface gives a Brinell hardness from 600 to 750. Chill is easily controlled, and it is also suitable for sand casting.

A MEMORANDUM recently issued by the National Smoke Abatement Society makes the startling statement that more than £2,000,000 a year is spent by property owners in this country to repair the damage done to buildings by smoke. The Society, therefore, emphasises the importance of reducing smoke emission to a minimum in slum clearance re-planning schemes. The late Sir Frank Baines, formerly Director of the Office of Works, estimated the cost of repairs to building property directly due to coal smoke during the last twenty-five years as in the region of £60,000,000.

ONE of the most important uses of pitch is in the manufacture of briquettes of powdered coal. The effectiveness of the pitch in covering the coal particle is probably dependent on the viscosity—the property which governs the empirical tests now applied to pitch. The viscosity of typical pitches has been measured by A. B. Manning—Fuel Research Technical Paper No. 39 (London: H.M. Stationery Office)—using three different methods to cover the range 30 deg. to 110 deg. Cent. The results showed that all the coal-tar pitches examined behaved as truly viscous liquids. Experiments made with bitumen—that is, petroleum pitch—showed anomalies analogous to those of colloids.

AT a recent meeting of the Overhead-Lines Association in London on September 20th, the methods used in North America and Scandinavia for distributing overhead lines were discussed. Mr. A. L. Stanton, President of the Association, said that it is difficult to make comparisons between the methods used in different countries, as the everyday conditions vary widely. In the United States not more than 5 per cent. of the street lighting is done by gas and not more than 25 per cent. of the factory supplies comes from independent stations. The early development of many American supply systems was governed mainly by utilitarian considerations, not much attention being paid to securing continuous service, voltage regulation, and avoidance of danger risks.

A NOVEL method of lining cylinders, covered by a German patent, is described in the *Automobile Engineer*. It consists of using thin sheets of Swedish steel rolled up into sleeves and nitrided. The sheets after being rolled up and hardened are not brazed or welded together, the edges being simply ground accurately and butted together. An arbor is placed in the sleeve and then forced into the cylinder block. Owing to the accuracy with which these sleeves are finished, all they require after being forced into place is a honing or polishing operation, which leaves the surface with a hard mirror-like finish. It is stated that the joint can be detected only with great difficulty. Better cylinder lubrication and longer life are some of the claims made for this method, which is applicable to both new and rebored cylinders.

AMONG the more unusual travel instructions issued in winter by the Canadian National Railways are those relating to the mining fields of Western Canada. To reach the San Antonio Mine in Northern Manitoba, the traveller is directed, says *Canada*, to travel by train to Pine Falls, then to take tractor over a winter road 45 miles long to the mine. To reach the Wekusko or Herb Lake field, he must take train to Mile 81 of the Hudson Bay Railway, where he will find dog team and sleigh awaiting him. If he wants to go to God's Lake, he must go by train to Mile 137 and there take aeroplane to the field. Red Lake gold mining area may be reached by train and aeroplane, or by train and tractor. Winter roads are made on the snow, and for that reason short cuts are possible, neither lakes, rivers, nor bogs presenting obstacles at this time of the year. One winter road to a mining field is 145 miles long, and traffic on it is conducted by caterpillar tractor drawing sleighs.

IN discussing the subject of piping systems for high-pressure steam, before the Liverpool Engineering Society, Mr. A. G. Bugden said that the design of piping systems demands as much consideration as any part of the plant and should receive attention when the location of the various units and auxiliaries is being decided upon, as an efficient and economical lay-out affects the arrangement of the whole plant. One factor which has drawn considerable attention to the design of the details of modern steam pipework is the phenomenon known as "creep." Allowable stresses "on the safe side" produce pipes of thicknesses greater than working conditions warrant and the greater the thickness the less the flexibility. Lack of flexibility tends to increase expansion stresses, necessitating still thicker pipes—and thus the vicious circle proceeds. The obvious remedy is pipework of as small bore as possible, and engineers should accept steam velocities as high as is consistent with reasonable pressure drop. Apart from the question of loss of pressure, the factor which limits velocities is the erosive action of the steam on valve seats and this is especially serious with saturated steam. The velocity of wet steam should therefore be less than that of superheated steam, and the following values should be regarded as maxima:—Exhaust steam, 100ft. per second; saturated steam, 130ft. per second; superheated, 200ft. per second; these figures being reduced by about 20 per cent. for diameters of less than 9in.

Miscellanea.

THE Caerau Colliery, one of the largest pits in South Wales, has been reopened after being closed two years.

THE extension of the Johannesburg municipal power-house by 15,000 kW is to be carried out at a cost of about £280,000.

THE hydro-electric power plant of Canada was increased by 270,210 horse-power during last year, making a total of 7,332,070 H.P.

THE Kroonstad Council, South Africa, is changing over its electricity supply from direct to alternating current at a cost of £60,000.

ACCORDING to the *Hamburger Nachrichter*, some twenty short-wave transmitters are to be erected in Germany for the purpose of television transmission.

THE South African Government has decided to construct a dam across the Vaal River, about Vereeniging, at a cost of about £1,000,000, for supplying irrigation water.

HULL Corporation Waterworks Committee has decided to begin preliminary survey work for its £1,000,000 scheme for obtaining a supplementary supply from Farndale Valley in North Yorkshire.

IT is proposed to form a company with a capital of £1,000,000 to construct and operate an underground railway in Santiago, Chile. This will be the first undertaking of its kind in the country.

THE First Narrows pressure tunnel, constructed for the Greater Vancouver Water District, cost 33,429 dollars less than was estimated, the main contract being 957,144 dollars. Accessory contracts brought the total cost up to 1,260,000 dollars.

WORLD consumption of nickel, says Mr. R. C. Stanley, in all forms for the first ten months of 1933 was 77,609,280 lb., as compared with slightly more than 49,500,000 lb. in the same period of 1932 and with the 112,481,600 lb. of the corresponding part of the peak year 1929.

THE Suez Canal Company will, from April 1st, reduce dues on ships passing through the canal. Dues on ships with cargo will be reduced by 25 centimes gold per net register ton (Suez Canal measurement), and dues on ships passing through in ballast will be reduced by 12½ centimes gold.

A COMPANY with a capital of about £200,000 is to be formed to carry out a scheme for the manufacture of cement and allied products in North Lincolnshire. The promoters have already acquired a considerable area of land in the neighbourhood of Winteringham and South Ferriby.

A RECENT report states that a sum of £2,000,000 has been allotted by the Soviet authorities to the extension of the wireless system in the U.S.S.R. during 1934. There are at present about 2,000,000 wireless receiving sets in the country, but during 1934 more than 950,000 new sets are to be constructed.

AN American manufacturer of breathing apparatus for use in gaseous atmospheres has, according to *Steel*, equipped the face piece on the canister mask with an arrangement which enables the wearer to speak and be heard distinctly. The advantage is that men working together and both having masks can converse readily.

THE contract for the erection of the last ventilating station for the Mersey Tunnel at Morpeth Dock, Birkenhead, has been placed with Sir Robert McAlpine and Sons. The price is £102,000, and the work is to be completed in fourteen months. The cost of all the ventilating stations will be £570,000, or £17,000 less than was anticipated.

THE Commercial Secretary to H.M. Embassy at Istanbul advises that in future goods exported to Turkey and bearing indications of weight, length, &c., should be marked in the metric system only. The marking of goods with the length or weight according to English standards, even if they are also marked in the metric system, is held to be contrary to the regulations.

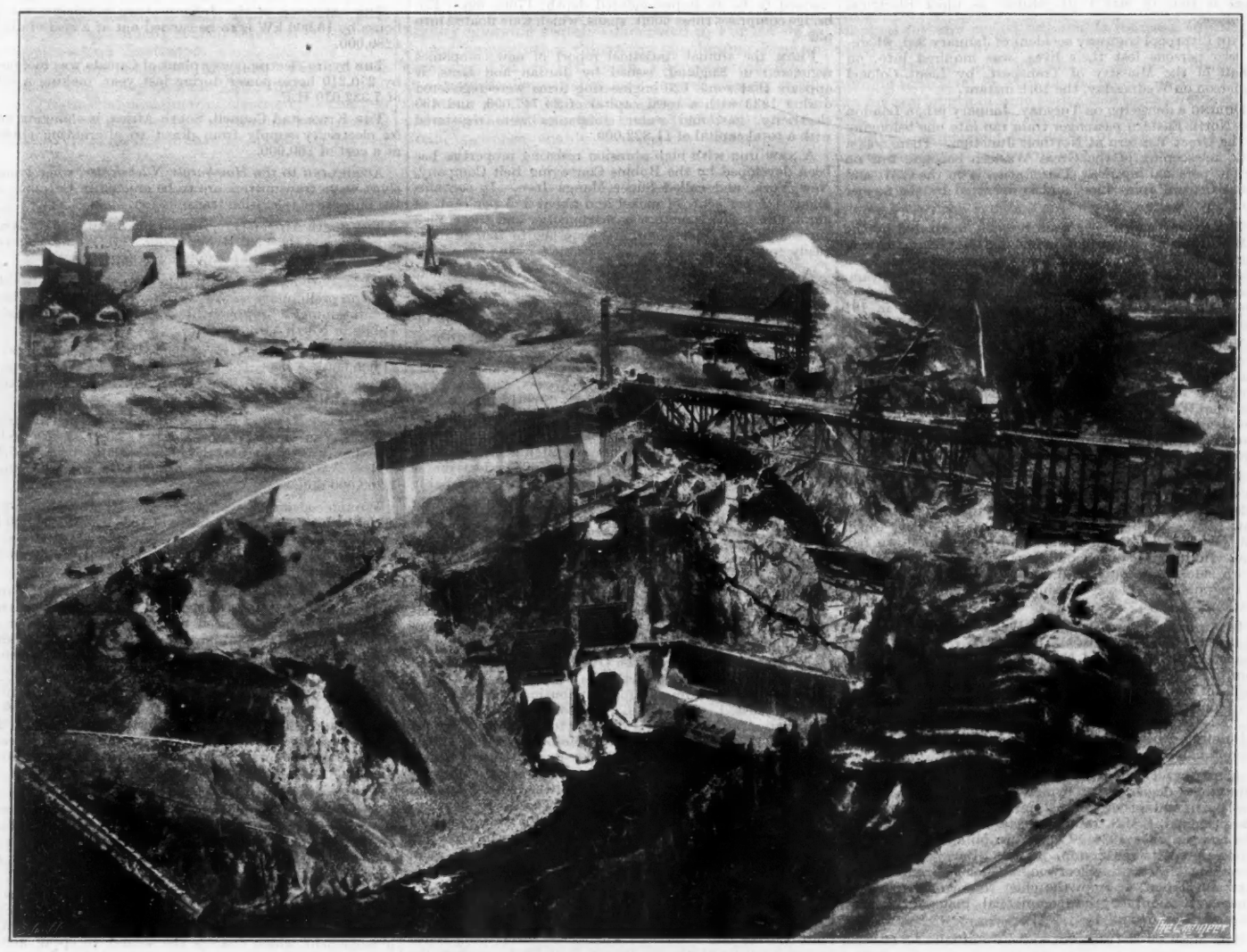
IT is estimated that there is 15,000,000,000 dollars invested in highways in the United States, and Mr. T. H. MacDonald, Chief of the Bureau of Public Roads, states: "If maintenance should be relaxed, the effects would be seriously noticed in thirty days. Within six months the money loss would be so great, by reason of depreciation and reduction in earnings from petrol tax revenues, that there would be insufficient funds left to the states and counties for fixed charges and maintenance alone." At present, while there are more than 3,000,000 miles of public highways in existence in the United States, only 150,000 miles have been paved.

THE papers to be presented before the Institution of Chemical Engineers on January 31st are the outcome of recent investigations on the efficiency of gasworks purification plant. The results of some of the work in connection with the efficiency of gas condensation plant have already been published. A detailed study of the gas-washing process follows logically upon the work on condensers, and is a necessary preliminary to any further studies of gas purification processes. The underlying principles have been examined in some detail. The methods of examination are such that while the work should be of immediate interest to the gas industry, the results should be available to any other industry in which gases are washed by liquids.

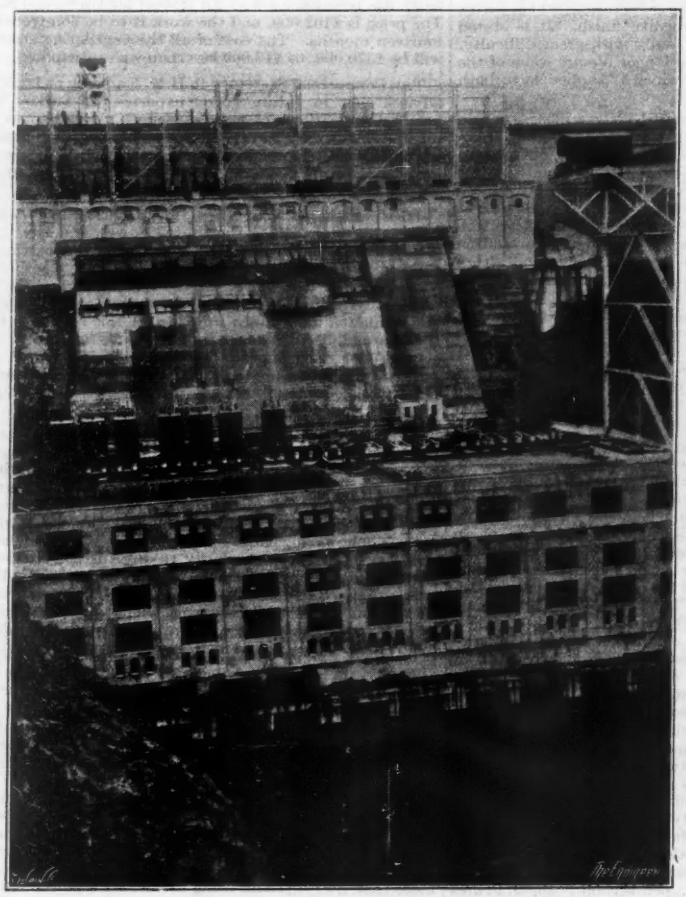
A NOTE in the *Electrical Review* states that there is a scheme for building an electric railway in Turkey for the conveyance of coal from the Eregli-Songuldak field and to connect with the Angora–Filios line. It is estimated that when the port works at Eregli are completed in about five years' time, over 1,000,000 tons of coal will be carried to that outlet by means of the new railway. The present output of the mines is at the rate of 1,600,000 tons annually, but this is expected to be increased to 3,000,000 tons in five years. About £500,000 is estimated as the cost of constructing the 53 miles of railway between Eregli and the most convenient point on the line to Filios, more than half this sum being needed for a power station, which would be steam driven, and use a large quantity of coal dust which at present is wasted.

ABITIBI CANYON POWER DEVELOPMENT

(*For description see page* 78.)



GENERAL VIEW OF SITE SHOWING ENTRANCE TO DIVERSION TUNNELS



POWER-HOUSE AND HEADWORKS

INTERIOR OF POWER HOUSE

The Engineer

JANUARY 19, 1934.

VOL. CLVII. No. 4071

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NOTICES TO READERS.

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SCIENCE AND SOCIABILITY.

OUR own representative at the Sectional Meeting of the World Power Conference in Copenhagen, and others who were present, have told us that the papers were so numerous and the social engagements so manifold that it was well-nigh impossible to get down to serious work. This is no new complaint. It is heard not only after every meeting of the World Power Conference, but also after the annual gatherings of less colossal bodies. Indeed, some institutions, recognising the impossibility of obtaining attendances for papers and discussions at Summer Meetings, have either reduced their number to the irreducible minimum or have deleted them wholly from the programme, which has then been devoted to sight-seeing and social functions. The wisdom of that step cannot be doubted, for it is neither efficient management nor courtesy to ask authors to present papers in rooms which are more distinguished by a multitude of empty seats than by the serious attention of members. But at the same time we are in some manner of doubt that the advantages of common fellowship which are advanced in support of large mixed meetings is not in danger of destroying some of the valuable properties of peripatetic forgathering.

There was a time, not so many years ago, when the summer or autumn meetings of the greater institutions were important events. The partakers went to them in all seriousness. The visits were carefully arranged to give the members an opportunity to extend their knowledge, and the papers were of a high standard and were treated with due respect. A member was in real danger of missing something valuable if he did not go to the summer meeting of his institution or society; nowadays, he and his wife are more likely to miss some enjoyment. The change may be a good one. There is no question that many sound and profitable friendships are made at these pleasant gatherings, nor that the ladies play an important part in bringing the men together. We do not suggest for a moment that the present kind of summer meeting should be given up; if anything, we admire the thoroughness of those institutions which make no pretence that it is much more than a social affair. But whilst we would not disturb the summer meeting as it now stands, we feel that there should be at least one general meeting a year of a more serious kind, a meeting which would not be agitated by the presence of the fair sex, but would devote itself wholeheartedly to matters connected with the affairs proper to the institution. It should not be a long meeting, three days at most, and by preference there should be a distinct concentration on one or two outstanding questions of the day. We are not forgetting that such *ad hoc* conferences are called from time to time, nor are we unmindful that some institutions adhere to the old practice of holding one or two general meetings a year, instead of one a fortnight or one a month, as the case may be. Our attention at the moment is directed towards the greater institutions—the "Mechanicals," for example—which not only hold monthly meetings at headquarters, but branch meetings at fairly frequent intervals in provincial centres. The establishment of branches was no doubt inevitable in face of the growth of the institutions in question, but equally there can be little doubt that their tendency is to disintegrate the activities of the institutions, if not the institutions themselves. Each branch becomes a separate centre, as far as its meetings are concerned, sometimes finding its own papers, more often hearing and discussing papers which have been or will be presented at headquarters. What is the result? It is that never do we have a completely representative single discussion on one paper. London does not go to Birmingham or Manchester to hear a debate, and Birmingham and Manchester do not come to London. The discussion is conducted piecemeal with some inevitable overlapping, and with some loss of effect. It may be said that a paper which is discussed a dozen times at different centres will be more thoroughly handled than a paper which is discussed but once. That is true, but the only person to secure the full benefit is the author himself if he is unfortunate enough to have to attend all the meetings in person. It is sometimes contended that all the discussions ought to be printed in the "Proceedings" of the institution, so that all the members might be able to examine them, and that by that means the segregation by branches would be corrected. It must be admitted, however, that the result would never be quite the same, and the expense entailed in editing and publishing the "Proceedings" is, where this plan is followed, greatly increased. But the greatest loss is due to the fact that all those qualified to speak are not present at the same time, and the mutual effect of their speeches is lost.

For these reasons we would be glad to see our major institutions giving more attention to the conferences on selected subjects which used to form an important item in their programmes, and we suggest—particularly to the Institution of Mechanical Engineers—that every spring it should hold a two or three-day conference with which no social functions would be associated. Such conferences, if carefully organised and expressly directed to one of the leading engineering questions of the day, would not only be invaluable to the members, but would attract much greater attention in the world as a whole than is given to the ordinary monthly meetings. They would, moreover, have the very important effect of bringing together once a year all the leading men, from all the branches of the Institution. Valuable as may be the social advantages of mixed meetings, there can, we think, be no doubt that a serious gathering would be of greater value to the members as a whole, of whom it must ever be remembered but a very small percentage are benefited by social functions.

Reinforced Concrete—A Code of Practice.

A WEEK ago—see our "Journal" of last week—there was issued by the Department of Scientific and Industrial Research a document which is likely to influence materially the development of reinforced concrete construction in this country. It is the report of an authoritative committee, under the chairmanship of Sir George Humphreys, appointed in 1931, at the request of the London County Council and the Ministry of Health, to "review present methods and regulations for the use of reinforced concrete in building and to make recommendations for rules of practice embodying the best available technical information and experience." The report is accompanied by a somewhat detailed set of rules and recommendations called by the Committee "a code of practice." The report states that, "apart from the national need for authoritative rules of practice, the London County Council had specifically asked to be furnished, in connection with the review of the London Building Act, with recommendations for a code of practice for the use of reinforced concrete in buildings similar to that drawn up by the Steel Structures Research Committee for the use of structural steel." The view is also expressed in the report that use will be made of the code in the model by-laws issued from the Ministry of Health. The code is limited in scope to the use of reinforced concrete in buildings (other than reservoirs, tanks, and structures designed for the storage of fluids), but it is obvious that many of its provisions will apply to a wider range of structures than is indicated by the word "buildings." The Committee has based its recommendations on existing knowledge and experience. No funds were available for research work to be undertaken expressly for the purpose of the Committee's investigations. At the same time, it is pointed out that full use has been made of a mass of valuable data available at the Building Research Station resulting from experimental work done in recent years under the direction of the Building Research Board. The Reinforced Concrete Structures Committee comprises representatives of the Institution of Civil Engineers, the Royal Institute of British Architects, the Surveyors' Institution, the Institution of Structural Engineers, and other institutions and associations representative of engineering and the building industry. The names of those who comprise the drafting sub-committee primarily responsible for the code will carry authority. In addition to the chairman, Mr. David Anderson, its members include Sir George Humphreys, Dr. Faber, Mr. E. S. Andrews, Mr. W. L. Scott, Mr. R. H. H. Stanger, Mr. B. L. Hurst, Mr. D. H. Green, and Mr. E. W. Butler, with Dr. Glanville, of the Building Research Station, as technical officer.

In the past rigid adherence to regulations has often barred the development of new methods of construction, and has even made it uneconomical to make the best use of the materials available. The code recommended by the Committee has been drawn up so as to assure good practice, while, at the same time, the door is left open to the adoption of new methods when and where they are adequately established. In the face of the stresses in concrete hitherto permissible there has been little incentive to make the best use of this material. The Committee has been impressed by the great improvements realised in the manufacture of cements and the preparation of aggregates, and has come to the conclusion "that industry has at this time reached a stage in development when advantage should be given to the engineer who is prepared to spend time and money in producing consistently controlled concrete. In other words, the day has passed when one stress only should be permitted for a mix regardless of the care exercised and the general level of strength achieved." The Committee has accordingly proposed three grades of concrete. The first, Ordinary Grade, corresponds to the usual 750 lb. per square inch stress for the weakest mix of concrete considered (1 : 2 : 4) with appropriate increases in stresses for richer mixes. This is for use where rigid control is not exercised. The second grade, termed High Grade concrete, calls for proof of strength by preliminary tests, for greater control of concrete quality, and for a definite programme of works tests. The stresses permitted are roughly 25 per cent. greater than for Ordinary Grade concrete, and represent present-day practice in high-class concrete work. The third grade, termed Special Grade concrete, calls for greater exercise of control and more frequent testing. For this grade preliminary test results are made the basis of working stresses, which may be as high as 25 per cent. in excess of those permitted for High Grade concrete. Dr. Stradling, the Director of Building Research, in a prefatory note to the report, says "it is of interest to mention that, during the past six months, the Building Research Station has had the opportunity, in connection with other work, of carrying out systematic strength tests, according to the methods laid down in the recommended Code of Practice, in the course of the construction of a number of reinforced concrete buildings. No special attempt was made by the firms concerned to control the quality of the concrete, and it is fair to assume that the concrete is representative of modern practice. The results have shown conclusively that the levels of strength demanded for the works' tests can be maintained with ease. In one case the lowest individual cube strength recorded was 100 per cent. above the strength required for High Grade concrete, in another case the margin was 55 per cent., and in the worst case 15 per cent. Parallel preliminary tests have been made at the Building Research Station, and in every case the works' cube strengths obtained satisfied the

requirements for Special Grade concrete." When it is realised that concrete has been produced throughout certain large works in London of a strength consistently higher than 6500 lb. per square inch, and in some cases as high as 10,000 lb. per square inch, the justification for increased permissible stresses will be appreciated. Steel stresses have also been increased above those permitted by the present London County Council regulations provided certain conditions as regards yield point stress are satisfied in order to give a reasonable factor of safety. It is of special interest to note that the yield point figure is taken as the criterion; this is in accordance with the best Continental and American practice, but is new in Great Britain. "In the opinion of the Committee an adequate factor of safety is assured by making the permissible stress approximately 0·45 of the yield-point stress." Except for direct stress in compression, these permissible stresses for steel do not, however, represent any departure from existing practice in certain parts of the country. To some extent this recommendation of the Committee seems to anticipate the recent alteration in the British Standards Specification for Girder Bridges by which the basic unit tensile stress for steel is increased from 8 tons to 9 tons per square inch. The Committee's report is dated July, 1933, and the recent revision in the British Standards Specification was made only at the beginning of the present year. Many of our readers will be aware of the valuable work done at the Building Research Station on the creep or flow of concrete under load, the effect of which is always to transfer load from the concrete to the steel. Modifications have been adopted by the Committee which, in effect, allow for that transfer. Thus, whereas formerly the steel in axially loaded columns was stressed to 9000 lb. per square inch, stresses up to 15,000 lb. per square inch are now permitted. Simplified methods of bending moment calculations are allowed by the code and certain reductions are permitted at points where practical difficulties of concrete consolidation are likely to arise, provided sections elsewhere are appropriately strengthened. Another matter of recent development is the method outlined for the design of slabs spanning in two directions at right angles. Under existing regulations simply supported slabs are the only ones specifically dealt with, whereas the new method provides also for slabs continuous on all sides. Particular attention is given in the code to the design of columns and of flat slabs supported by them without the intervention of beams.

A notable feature of the code is the absence from it of ordinary formulæ. The principles involved are clearly stated, but the actual detailed application is left, as it should be, to the designer. The basic theory of design is developed in sufficient detail, and the constants and other quantities to be used in design are fully covered by the rules. In the recommended code, therefore, "formulæ have not been given where they constitute part of ordinary theory, or where they flow directly from the assumptions stated." An attempt has been made to standardise ordinary definitions and notation, and considerable space is devoted to clauses in the code, as well as to appendices, dealing with standard methods of testing of aggregates and concrete samples and the permissible limits of load on materials and foundations. Finally, encouragement is given to utilise special forms of construction and special materials wherever they conform to standards of strength and durability at least equivalent to those demanded by the code of practice. We have indicated the scope and nature of the code in sufficient detail to show that its value extends far beyond the requirements of ordinary building construction, to which, of course, it is primarily intended to apply.

Scientific and Industrial Research.

No. I.

THE annual report of the Department of Scientific and Industrial Research was published by H.M. Stationery Office, price 3s., on Saturday of last week, and from it we take the following information concerning the activities of the Department during the year ending September 30th, 1933.

The Million Fund.

During the year the Government grant of £1,000,000 made in 1917, and known as the Million Fund, became exhausted. The Fund has been used by the Department for assisting the formation of co-operative research associations in various industries, maintained partly by grants from the Department and partly by subscriptions from industry. Although the Million Fund is no longer available, the Department's grants are now being made from its Parliamentary Vote. The act of expending the Million Fund has attracted a total industrial contribution of £1,750,000. At the moment the State is contributing £65,000 a year and industry £170,000 a year towards the support of a group of nineteen research associations, which include in their membership some 5000 firms, covering a field of manufacturing industries providing about 50 per cent. of the total exports of the country.

While it is impossible, as a rule, to assess in terms of money the part played by the research associations in the industrial progress of the country, some concrete examples show that that part is important. Annual savings amounting to not less than £1,000,000 per annum have accrued from research work carried out by the Electrical Research Association, costing £80,000 in all. A saving in fuel and other economies amounting to £200,000 per annum should result from recent investigations of the Cast Iron Research Association. The Iron and Steel Research Council has completed research work which should result in a saving of about £392,000 worth of coke per annum in the production of pig iron and a saving in coal of no less than £1,341,000 in the production of finished steel. Work carried out by the Refractories Research Association has prolonged the life of certain types of fire-clay boxes in which pottery is fired from seven firings to 200 firings.

An annual sum of less than £250,000 is trivial, the Advisory Committee argues, in relation to the interests involved and the possibilities awaiting realisation. The basis on which many of the research associations are working is hardly commensurate with the size of the industries they serve. The average expenditure of the nineteen research associations, which represent industries having an aggregate net output of some £440,000,000, is £14,500 a year apiece, but if the six associations spending over £14,000 each are eliminated, the average for the remaining thirteen is only £6765 each.

The average contribution to the research associations amounts to no more than about 7s. 6d. per £1000 of net output.

Road Research.

An important addition to the Department's responsibilities was made during the year by the decision of the Government to transfer from the Ministry of Transport to the Department the duty of directing and supervising the conduct of road research. A Road Research Board was accordingly constituted. Its official headquarters will be in the Road Research Laboratory at Harmondsworth already provided by the Ministry of Transport and now to be enlarged. Substantial sections of the programme will be carried out at the National Physical Laboratory and the Building Research Station, and close contact will be maintained with the work of the Chemical Research Laboratory at Teddington on tars used as binders in road construction. Dr. Stradling will act as Director of Road Research, in addition to fulfilling his other duties as Director of Building Research. The problems to be attacked are interesting and important. Surprising success has been achieved in modern road construction, but often at high cost. Very little scientific knowledge exists of either the foundations of the road or of the materials of its superstructure, such as will ensure that a success in one place can be repeated in another.

National Physical Laboratory.

International Standards.—The results of the determination of the absolute unit of electric current by means of the ampère balance are now available, and it is found that the absolute ampère is greater than the international ampère by 12 parts in 100,000, the ratio being subject to a maximum uncertainty of 4 parts in 100,000. Good progress has been made in the absolute measurement of resistance by means of the Lorenz apparatus and preliminary results have been obtained. An international comparison of resistance coils and standard cells has been undertaken during the year. The results show that the international ohm as maintained at the National Physical Laboratory is 3 parts in 10^6 less than that of the Bureau of Standards, 18 parts in 10^6 less than that of the Physikalisch-Technische Reichsanstalt, and 73 parts in 10^6 less than that of the Laboratorie Central d'Electricité. In connection with the international temperature scale an intercomparison of thermocouples has been carried out by the Bureau of Standards, the Reichsanstalt and the National Physical Laboratory, as a result of which the thermocouple scales maintained at the three laboratories have been brought into agreement within 0·1 deg. Cent. at all points of the range 660 deg. to 1063 deg. Cent.

High-voltage Research.—The high-voltage plant was extended during the year by the addition of an impulse generator, by means of which it is now possible to test transmission line insulators under impulsive conditions up to a million volts. The problem of measuring the maximum voltage given by the plant is being attacked in a novel manner by an attempt to develop a vacuum condenser capable of withstanding the full voltage of the plant. Satisfactory results have been obtained up to 300 kV with a condenser designed and constructed at the Laboratory.

Physics Department.—In the Heat and General Physics Division the investigation into the thermal and electrical conductivities of heat-resistant alloys has yielded the important result that the thermal conductivities of the alloys examined tend towards a common value in the neighbourhood of 1000 deg. Cent. Preliminary results for the ratio of the specific heats of carbon monoxide at temperatures up to 1700 deg. Cent. show a reduction in the value of the ratio, but not to the extent indicated by spectroscopic data. Research on the internal structures of materials by means of X-ray spectrometry proceeded in the Radiology Division. It has been shown that the effect of the cold-drawing of metal wires is to produce lattice distortion followed by selective orientation in the later stages. This work has been continued by a study of the effect of cold rolling on metals, in which similar results were found.

In the Sound Division the investigation upon noise in aircraft was continued on behalf of the Air Ministry and assistance was rendered in connection with the acoustical features in the design of aircraft.

Electricity Department.—In addition to the work relating to international standardisation, measurements were made during the year on the standard resistance coils of the British Association, dating from 1865. The results suggest that platinum is considerably superior to other materials for the construction of permanent standards of electrical resistance, and a number of new platinum coils have therefore been constructed for laboratory use. It is of the utmost importance that materials used in the construction of coils for fundamental electrical standards shall be non-magnetic. Tests made on marble and fused silica—materials largely used for this purpose—have, however, shown that these substances are slightly diamagnetic. A sample of glass was also found to be diamagnetic, but a porcelain proved slightly paramagnetic. The study of current transformers was continued, and in view of the growth in the size of generating units, problems involved in testing transformers of large ratio, up to 20,000/5, have been studied. An instrument has been designed to give a rapid indication of the form factor of alternating current wave shapes. As regards direct-current measurements, initial results have indicated that a valuable improvement in the secular stability of manganin resistors results from annealing at 550 deg. Cent. after shaping for mounting; observations over a prolonged period will be necessary to ascertain the ultimate value of this treatment. A new method for the measurement of very high resistances has been devised, in which the rate of loss of charge of a condenser connected in parallel with the resistance is determined. The researches on cables in progress for the British Electrical and Allied Industries Research Association have been continued and the Division is collaborating with the Chemical Research Laboratory in elucidating the effect of electric currents in leaden water pipes on the lead content of the water.

Metrology Department.—Arising from the recent change in the temperature of adjustment of industrial length standards from 62 deg. to 68 deg. Fah., the more important standard end gauges of the Laboratory have been reverified during the year, and, where necessary the measuring machines have been recalibrated. Stability tests on heat-treated hardened steel gauges have been continued, and further attention has been given to the selection of suitable steels for making standard gauges. Preliminary work has been done on the nature and magnitude of the distortion of the screw threads when a nut is tightened on a bolt. A machine has been devised to measure the diameters of fine wires, such as are used for electric lamp filaments. Variations in diameter can be measured to a millionth of an inch, and the absolute diameter at any point to an accuracy of within $\pm 0{\cdot}000003$in. The vibration clock has reached a stage where it is evident that high uniformity of rate can be obtained, and before the precise degree of constancy can be ascertained an improved standard of comparison is needed. Comparisons with the quartz ring oscillator of the Electricity Department will be undertaken, and it is also proposed to construct a new free-pendulum clock with a fused quartz pendulum electro-statically maintained.

Engineering Department.—A method of testing metal coatings and thin sections for hardness has been developed, and an apparatus for diamond pyramid static hardness tests at small loads has been designed and constructed. Experience with this apparatus suggests that the method can be definitely recommended for use on such materials. The

machine for the research on the resistance of metals to wear has been redesigned; specimens can now be tested under pure rolling or pure slipping, as well as under combined rolling and slipping, and arrangements are made whereby the test specimens may be enclosed in a rubber case in order to carry out tests in various ambient atmospheres.

Work has been continued on the general investigation of fatigue phenomena, series of tests having been made on single crystals of bismuth. and on specimens of aluminium consisting of two crystals. In connection with the study of corrosion fatigue, tests have been carried out *in vacuo* to determine the effect of removing atmospheric oxygen from contact with specimens subjected to cycles of alternating direct stress. It has been shown that in some cases the atmosphere has an influence on the fatigue resistance of materials when tested under normal laboratory conditions. A specimen of cupro-nickel showed no increase in fatigue strength when tested *in vacuo*, and only a slight increase in the fatigue limit was observed in the case of ferrous metals, but the effect was considerable with copper and brass, particularly the latter, where an improvement of 26 per cent. was obtained in a partial vacuum. An investigation into the corrosion fatigue of certain aircraft materials has been carried out for the Aeronautical Research Committee; four testing machines are now available for making fatigue tests in salt spray. The effect of surface conditions on the fatigue resistance of steel has been the subject of further research, and experiments have been made to compare the fatigue resistance of unmachined heat-treated steel forgings with that of the same materials when machined and polished. The results indicate that the effect of the unmachined surface on the fatigue strength of forgings is not very marked for mild steel, but that in the case of steels which are heat-treated to give high tensile strength, machining and polishing leads to considerably higher endurance fatigue limits. In connection with the researches on fluid friction and heat transmission, experiments carried out on pipes of circular and of rectangular cross section have led to the important conclusion that heat phenomena in pipes of the type tested can be compared by using the hydraulic diameter as the length parameter. A considerable amount of further work has been done at the request of the Home Office in connection with the safety of lifting gear, both with regard to the design of standardised components and the examination of chains and fittings to determine the effect of periodic annealing. The effect of periodic annealing on the pitch of calibrated chains has been investigated, and the results indicate that annealing reduces the useful life of the chains, owing to the abrasive action of the scale causing excessive wear of the sprockets, and to the stretch resulting from the softening action of the heat treatment. The deleterious effect of periodic annealing on the screwed portions of fittings was found to be small at 650 deg. Cent., but at 750 deg. Cent. it may be somewhat greater. Prolonged annealing of swivels was found to be very injurious to the threaded portion.

Aerodynamics Department.—The general study of fluid motion has been continued, and the ultra-microscope has been used to reveal further details of the structure of turbulent flow. The method has also been employed to obtain information on the eddying wake behind a long prism having a triangular cross section. A method has been devised of indicating the transition from laminar to turbulent flow in the boundary layer of a model by means of a hot wire placed transversely in the boundary layer. The heated wake from the wire expands more rapidly in the turbulent than in the laminar part of the layer, thereby causing the temperature distribution across the wake to be different in the two parts; the regions of laminar and turbulent flow can therefore be determined by observing the character of the temperature distribution. Other investigations connected with the study of fluid flow have included the visualisation of air flow by means of hot-air shadowgraphs. The installation and calibration of the balance in the Compressed Air Tunnel have been completed, and the balance has proved satisfactory in operation. An exploration has been made of the distribution of velocity in the jet of the tunnel, and the flow has been found to be of the same order of regularity as in the atmospheric tunnels at the Laboratory. Investigatory work in the tunnel has been commenced. The performance of a number of aerofoil sections in common use is being determined with a view to securing comparison with full-scale tests in flight.

Metallurgy Department.—The investigation into the properties of steels for use at high temperatures, which is being carried out in conjunction with the Engineering Department on behalf of a Joint Committee of the Electrical Research Association and the National Federation of Iron and Steel Manufacturers, and which has for its object the development of more suitable materials for constructing boilers, superheaters, turbine rotors, and other parts exposed to high temperatures and pressures, has yielded further useful results. The properties of a number of steels have been determined, and apparatus for testing the corrosion of steel in superheated steam has been constructed. Experiments have also been continued on the corrosion of steel by flue gases.

William Froude Laboratory.—The research on the influence of waves on the resistance, propulsion and pitching of ships has reached a stage when the general effects of rough water upon the hull resistance are known, and progress has been made with the study of the action of a screw propeller when propelling a ship in a rough sea. Propulsion data obtained on a ship at sea have been compared with the results of tank experiments on a similar model hull self-propelled through similar sea conditions, the wind resistance of the superstructure of the ship being also taken into account, and the comparison has shown that the prediction of performance from model tests made in rough water can be accepted with confidence.

(To be continued.)

Obituary.

EDWIN SMITH.

IT is with regret that we learn of the recent sudden death, in his own car, of Mr. Edwin Smith, the managing director of Smith and Grace, Ltd., of Thrapston, near Kettering. Mr. Smith, who was eighty-six years of age, was for forty years in charge of the London branch of the firm's business, and attended the London office right up to the time of his death. He began business about 1860, at which time his firm was solely engaged in the production of agricultural implements. When the steam engine was introduced for farm work, the firm began to fit pulleys to chaff cutters, and other farm machinery, which previously had been turned by hand. The business rapidly increased and pulleys were supplied to other firms of implement makers, until, in 1885, it was necessary for the firm to devote all its attention to the power transmission side of its business, and to give up the manufacture of farm implements. The business grew until the firm has become, to-day, one of the largest manufacturers of pulleys and power transmission devices. In 1897 a limited liability company was formed, and the principal production of the firm—the screw boss pulley, an invention of the late Mr. Smith's brother—was greatly developed. The Thrapston industrial vee flat drive was also introduced. During a period of over sixty years Mr. Edwin Smith had personal charge of the sales side of the business, and his death will be regretted by a very wide circle of business friends.

Literature.

Richard Trevithick: The Engineer and the Man. By H. W. DICKINSON and ARTHUR TITLEY. Trevithick Centenary Commemoration Volume. Cambridge: At the University Press. 1934. Price 10s. 6d.

RICHARD TREVITHICK died in 1833, and the centenary of his death was honoured last year by events which were recorded at the time in our pages. The arrangement of the commemoration was undertaken by a committee of engineers, of which Sir Murdoch MacDonald was chairman, and Mr. H. W. Dickinson secretary. Before that committee came into being, Mr. Dickinson with Mr. Arthur Titley had begun to write a new life of Trevithick, and when these authors offered their MS. to the committee for publication as a Centenary Commemoration Volume, it was at once accepted. But a difficulty arose. The committee had succeeded in collecting enough money to pay for other details of its programme, but not nearly enough to pay for the publication of an important volume. At this point the board of Babcock and Wilcox, Ltd., came forward with an offer to bear the whole expenses of the volume, provided it was published at a low price. The offer was welcomed by none more cordially than by the authors who by so doing most generously gave away all their work for no more reward than the honour of authorship. The result must give them great pleasure. The book is all that can be desired; that is to say, it is produced in the best manner of the Cambridge Press, and it is available to the public at a much lower price than its obvious value would indicate. It is a Memorial Volume completely fitting to the great man it honours.

To write anything new about Richard Trevithick is at present impossible. His son Francis, to redeem his father's name from neglect, wrote and published a two-volume "Life" sixty-one years ago. He collected nearly every scrap of useful material, and all who have followed him have done little more than add glosses to what he had provided. There are many gaps still unfilled, and it is always hoped that in some attic or in some sale-room papers or books which will throw light upon hazy incidents may be discovered.

But Francis Trevithick showed more energy than discretion, more enthusiasm than acumen. His "Life" is a despair to all who study it. It has got everything in it, but mixed up with a great deal of evidence that is untrustworthy, and it bristles with unnecessary and provoking repetitions. The task which Messrs. Dickinson and Titley undertook was to unravel Francis's tangled story, to winnow the wheat from the chaff, to add what they honestly could, and, generally, to present a now-familiar story in a new dress. They have done their work admirably. The two thick volumes of Francis's "Life" are now reduced to one of reasonable size, many new illustrations have been added, and all the irritating redundancy has been cut away. They claim with justice that they present "a balanced presentation of a fascinating personality and of his career, by critical examination of existing material, some now adduced for the first time; by the evaluation of the motives of action of the men concerned in the story; by weighing the evidence of contemporaries; and by consideration of the state of the arts and of the economic conditions of the time." A word of warning to the unwary is called for. Frequent references are made to the Enys papers. These are, in fact, the sixty-four letters forming the Trevithick-Giddy correspondence preserved by the Enys family, and now in the possession of the Royal Institution of Cornwall.

The changes the authors made are indeed so radical that one even misses something. Francis, defying chronology, brought all the locomotive history into one section. This had the effect of stressing Trevithick's locomotive inventions. Perhaps Francis overdid it a little. On the other hand, the present authors follow a chronological arrangement which divorces the Camborne and Penydaren and Road Coach from the London circular railway and "Catch-me-who-can," and which has the result of lessening the effect of this side of Trevithick's work. Very likely they are right. "Capt. Dick" himself, according to them, deliberately and wisely decided to drop the locomotive and devote his energies to his other inventions. In these days, and in the light of what happened only a few years after his death, it seems strange and regretable to us that he did not pursue a subject which was certainly almost ripe for development. Others, as we know, soon took up the invention of locomotives, and when we regard the hash they made of them by comparison with the drawing of "Catch-me-who-can"—which, by the way, the authors accept—it seems fairly certain that Trevithick would have brought the engine to the stage it reached in the "Rocket". several years before that design laid the foundation of the railway system.

Trevithick will always remain amongst the most romantic of the pioneers of any nation, and his "Life" will always be one to which, not only engineers, but laymen will turn for entertainment and inspiration. There are short memoirs, excellent within their compass, but there was no full Life, except that by Francis, of which the reading was a tribulation to the flesh, and this new biography, beautifully produced, well illustrated, and lucidly written, will remain not the least of the memorials erected to the honour of a great engineer a hundred years after his death.

BOOKS RECEIVED.

William Garnet: A Memoir. By G. M. Allen. Cambridge: W. Heffer and Sons, Ltd. Price 3s. 6d. net.

"Mechanical World" Year Book, 1934. London: Emmott and Co., Ltd., 28, Bedford-street, W.C.2. Price 1s. 6d. net.

Plastic Moulding. By L. F. Rahm. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 18s. net.

Electric Welding. Vol. 2, October, 1932–August, 1933. London: Quasi-Arc Company, Ltd., 15, Grosvenor-gardens, S.W.1.

Elementary Engineering Thermodynamics. By T. H. Taft. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 16s. 6d. net.

Garcke's Manual of Electrical Undertakings and Directory of Officials, 1933–34. London: Electrical Press, Ltd., 13, Fisher-street, W.C.1. Price 35s. net.

The Practice of Engineering Estimating. By Percy H. Miller. London: Oxford University Press, Amen House, Warwick-square, E.C.4. Price 12s. 6d. net.

Mineral Resources of the United States, 1930. *Part 2, Non-metals.* Washington: The Superintendent of Documents, D.C., U.S.A. Price 1.50 dollars net.

Engineering Workshop Principles and Practice. Fourth edition. By A. G. Robson. London: Emmott and Co., Ltd., 28, Bedford-street, W.C.2. Price 7s. 6d. net.

The Action of Solvents on Coal. By W. E. Bakes, D.Sc., A.I.C. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2. Price 4s. 6d. net.

Library Buildings: Their Heating, Lighting, and Decoration. Edited by R. D. Hilton Smith. London: The Library Association, Chaucer House, Malet-place, W.C.1.

Janes Fighting Ships, 1933. Edited by Oscar Parkes, O.B.E., M.B. London: Sampson Low, Marston and Co., Ltd., 100, Southwark Bridge-road, S.E.1. Price 42s net.

The Official Year Book of the Scientific and Learned Societies of Great Britain and Ireland, 1932–33. London: Chas. Griffin and Co., Ltd., 42, Drury-lane, W.C.2. Price 10s. net.

Deutsch-Englisches Fachwörterbuch der Metallurgie. Deutsch-Englisch. By H. Freeman. Leipzig: Otto Spamer Verlag G.m.b.H., Crusiusstrasse 10, C.5. Price 25 marks.

The 1931 *Form of Building Contract.* By W. T. Creswell and C. G. Armstrong Cowan. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 7s. 6d. net.

Shipbuilding & Marine Engineering in 1933

No. II.

(*Concluded from page 20, January 5th.*)

Developments in Boiler Design.

THE past year saw many developments in the design of marine boilers, which, in future ships, should bring about important changes in the direction of higher steam outputs, increased efficiency, greater ease of working, and lower maintenance costs. Perhaps the most interesting marine boiler of the year was the Johnson Naval type boiler, which was built for Admiralty demonstration purposes, and was tested at the East Cowes works of John Samuel White and Co., Ltd., in the Isle of Wight. A full, illustrated description of this high-powered boiler unit, and its notable combustion performance, was given in our issue of December 29th. The extended and careful trials made with the boiler will, without doubt, furnish valuable information on which the future development of both naval and marine types of boiler will be based. It is of interest to record that during the past year orders were placed for installations of Johnson boilers for the Royal Mail liners "Asturias" and "Alcantara," now being lengthened and re-engined at Harland and Wolff's Belfast yard. Each set will comprise three boilers having a total output of steam corresponding to a turbine shaft horse-power of about 24,000. Steam will be produced at 400 lb. pressure with a safety valve release pressure of 450 lb. and a final temperature of 725 deg. Fah. The two boiler installations will include Howden-Ljungstrom rotary air heaters and Vortex dust collectors, and will be designed so that either two or three boilers will produce the full output of steam required. The fuel rating when two boilers are used, will be 12 lb. of oil per square foot of heating surface, and 8 lb. when under normal service conditions all three boilers are in operation.

Alongside the Johnson water-tube boiler developments progress has also been made with the Howden-Johnson cylindrical marine boiler, which was described and illustrated in last year's Annual Article. One such boiler has been constructed and will shortly be tested at one of the principal engine works on the Tyne.

Some recent developments in Babcock and Wilcox marine boilers were well illustrated at the Olympia Exhibition last autumn, and reference to these full-scale exhibits will be found in our Supplement issue of September 8th. The principal lines of development were, it will be recalled, the increasing use of mechanical stokers at sea, and a tendency in the direction of the employment of water-cooled walls in marine boilers. The 375 lb. pressure Babcock and Wilcox oil-fired water-tube boilers supplied for the "Queen of Bermuda" gave good results in service, while a new departure was made by installing a water-tube boiler in a comparatively small steam ferry boat, the "Janardan," which was constructed by Henry Robb, Ltd., for Indian service. It has a designed evaporation of 18,000 lb. of steam per hour at 225 lb. pressure, and is hand-fired with coal of about 11,500 B.Th.U. calorific value. The new "S X" small-tube boiler built for H.M.S. "Guardian" gave very satisfactory service, and the fuel consumption performance and the steam quality compared well with that of the other tri-drum boilers installed in the ship. We referred in our last article to some of the cross-Channel steamers which are to be equipped with Babcock and Wilcox boilers, and Erith-Roe mechanical stokers.

One of the largest boiler outputs of the year was recorded by Yarrow and Co., Ltd., of Scotstoun, Glasgow, the firm's total output of turbine machinery and boilers for British and foreign naval ships amounting to nearly 100,000 S.H.P. In particular, the 400 lb. pressure, 700 deg. Fah. final temperature boilers installed in the two Portuguese destroyers gave very satisfactory results in service. The same is true of the boilers designed by the firm for the Italian liner "Conte di Savoia." In this connection it is of interest to note that an agreement has been reached between the Cantieri Riuniti Dell 'Adriatico, of Trieste, and Yarrow and Co., Ltd., for the construction of the latest types of Yarrow boilers. This agreement will enable the British and Italian works to co-operate and interchange their experience in the design and operation of marine boiler plant. A noteworthy event of last year was the placing with Yarrow and Co., Ltd., of the order for the boiler plant for three train ferries for the Southern Railway Company, which will include the firm's patented superheaters and air heaters, and mechanical stokers of the Taylor type. Work is well advanced on these units, and also on several Naval boilers, besides land boilers for Great Britain and overseas. Following the extended trials of the Benson critical-pressure boiler installed in the Hamburg-American cargo ship "Uckermark," it was decided shortly before the end of last year to include a complete Benson boiler installation in a German liner of about 16,000 gross tons, which will be electrically-propelled and will be designed for a service speed of about 18 knots. It will be built by Blohm and Voss, of Hamburg, for the Far East service of the Hanseatische Schiffahrts und Betriebs G.m.b.H. The recent developments of the Benson boiler are to be described, it may be recorded, in a paper which is to be read by Dr. Ohlmüller, of the Siemens Schuckertwerke, Berlin, before the Institute of Fuel at a joint meeting of institutions to be held at the Institution of Electrical Engineers on Thursday, February 15th.

Turbine Machinery Developments.

A movement in the direction of the economical application of the steam turbine for smaller passenger steamers and cargo boats was made by the Parsons Marine Steam Turbine Company, Ltd., of Wallsend-on-Tyne, in collaboration with Mr. John Johnson, and during the past year a set of machinery of this type has been constructed and will shortly undergo ship trials. We illustrate in Fig. 13 a working model of one of the new Parsons Simplex turbine units, which was displayed at Olympia and described in our issue of September 8th, 1933. The propelling unit consists of two turbines working in series, one high-pressure and the other low-pressure. They drive a common pinion and through double-reduction gearing the propeller shafting. The design of the unit is so contrived that the turbine, gear casing, wheels, thrust block, and condenser, can be assembled in the works, and lifted into the ship in one piece. The design provides for easy and complete accessibility to all parts. Some idea of the probable weight and the performance of this unit is given by the following figures:—For an output of, say, 2000 S.H.P., which may be taken as equivalent to about 2200 I.H.P. at 75 r.p.m., the total weight is estimated to work out at about 56 tons. Assuming a boiler pressure of, say, 275 lb., with a final steam temperature of 750 deg. Fah., and a 28½ in. vacuum, the corresponding steam consumption will be about 8·0 lb. per horse-power-hour. The full-scale tests of this new type of turbine propelling unit will be awaited with considerable interest.

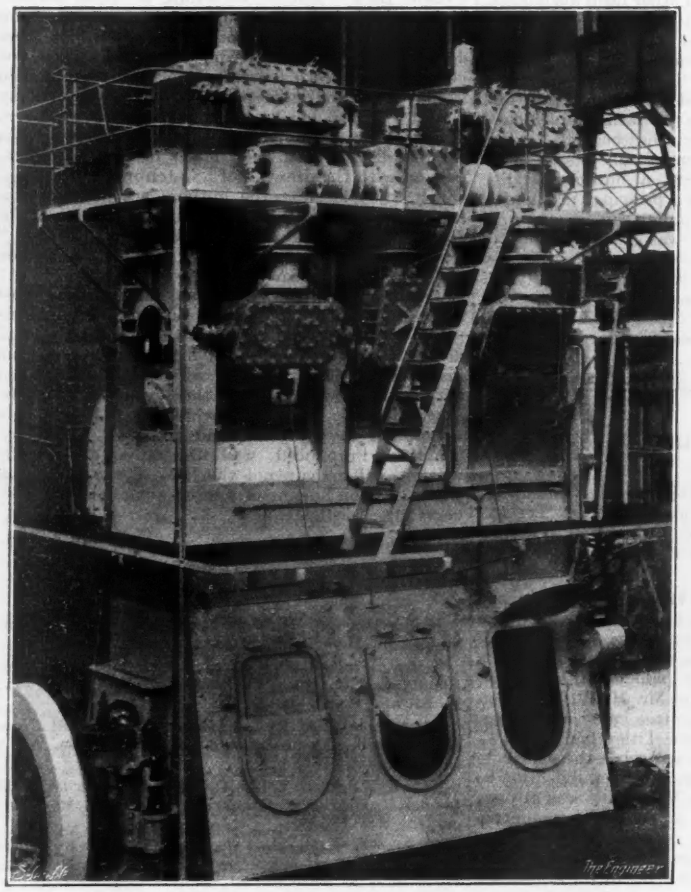


FIG. 9—2000 I.H.P. SEMI-UNIFLOW STEPHEN STEAM ENGINE

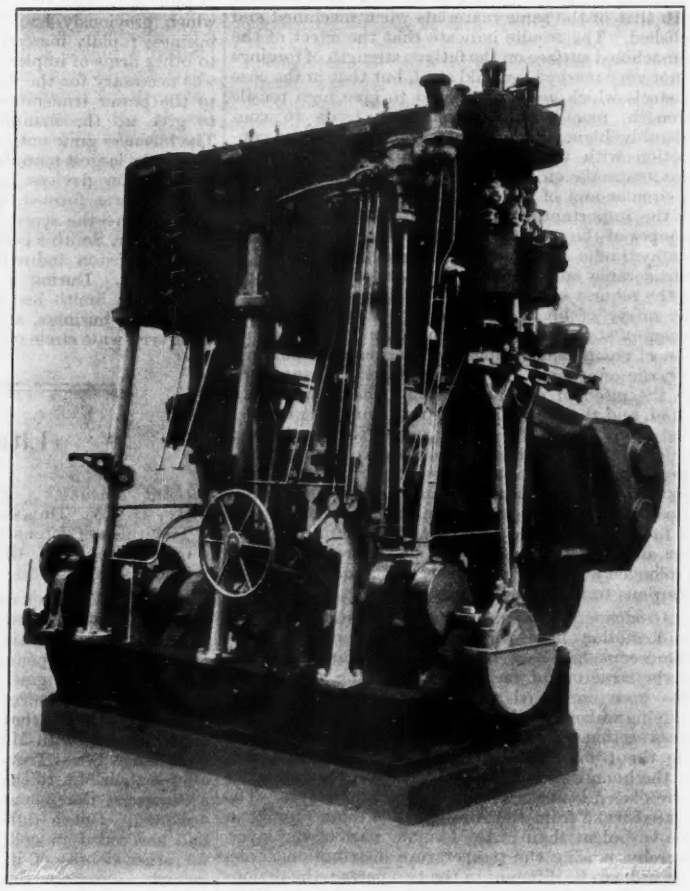


FIG. 10—1750 I.H.P. NORTH-EASTERN POPPET VALVE STEAM ENGINE

Reciprocating Engines Combined with Exhaust Turbines.

At the Dalmuir works of William Beardmore and Co., Ltd., and at the Wallsend works of Swan, Hunter and Wigham Richardson, Ltd., development continued on Bauer-Wach exhaust steam turbines, while at Dalmuir the Beardmore-Caprotti valve gear was manufactured for several sets of marine steam engines. Good progress was recorded in the application to British ships of the Götaverken patented exhaust steam turbo-compressor system. In ships engined by David Rowan and Co., Ltd., and Hawthorn, Leslie and Co., Ltd., with this system, overall savings in operation costs of 15 to 17 per cent. were recorded.

No installation was made of the Wallsend Slipway and Engineering Company's steam supercharging system, but later development of this principle may be expected. The combined reciprocat-

ing engine and exhaust turbine designed by Whites Marine Engineering Company, Ltd., of Hebburn-on-Tyne, was prepared for installation in the steamer "Adderstone."

On the electrical side, several exhaust turbo-electric installations by the Metropolitan-Vickers Electrical Company were fitted by Workman, Clark and Co. into several ships of the Ellerman City Line, and three of the City Line vessels were equipped with North-Eastern superheaters. Progress abroad included several ships in Scandinavia equipped with the Elsinore-Lentz exhaust turbine system. With this system coal consumptions under 1 lb. per I.H.P.-hour are guaranteed.

In a paper read before the Schiffbautechnische Gesellschaft in Berlin in November last, Dr. Ing. G. Bauer, of Hamburg, described and illustrated the general advance made in reciprocating steam engine and exhaust turbine design.

New Reciprocating Engine Developments.

One of the interesting new steam engines of the year was the 2000 I.H.P., three-cylinder, semi-uniflow steam engine designed and tested by Alexander Stephen and Sons, Ltd., of Linthouse, Glasgow, and shown in Fig. 9. It was described and illustrated in THE ENGINEER of October 27th. Shop trials made with only 185 lb. steam pressure and a speed of over 100 r.p.m. to suit brake conditions showed, with an output of 1600 I.H.P., a mechanical efficiency of 95·9 per cent., and a steam consumption of 10·15 lb. per I.H.P.-hour. An engine of this type will be installed in the new coastal cargo liner "Dundee," which was launched from the yard of the Caledon Shipbuilding and Engineering Company, Ltd., at Dundee on the last day of 1933.

One of the most important reciprocating engine installations of the year was that designed by the North-Eastern Marine Engineering Company, Ltd., for the new Isherwood Arcform steamer, "Arcwear"—see Fig. 10. The ship was built by Short Brothers and Co., Ltd., of Sunderland, and was completed at the end of 1933. She has recently undergone official trials, with, we learn, most satisfactory results. The new Arcform of ship, which has previously been referred to, is characterised by a ship's section, which, instead of the straight side, gives a single, easy bulge, with well-rounded bilges and a considerable tumble home. The experimental tank results showed a wide range of economical speeds. With the propelling machinery fitted in a ship 360ft. long, 57ft. 6in. beam and of about 7000 tons deadweight carrying capacity, it is expected that consumptions of 21, 16, and 11½ tons of coal per day for corresponding speeds of 11, 10, and 9 knots in a loaded condition will be obtained. These estimated figures were, we understand, borne out in the recent trial, and further records are to be taken in the later loaded trials and on the first voyage of the ship.

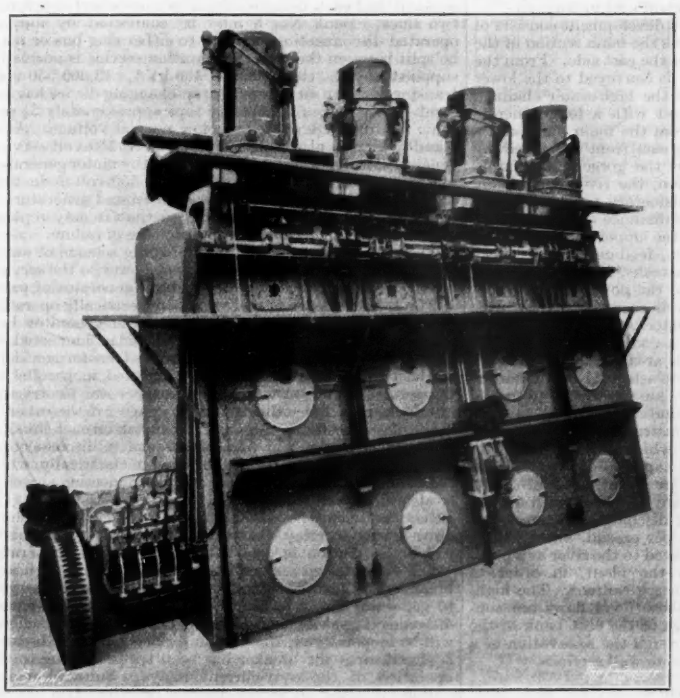


FIG. 11—2900 S.H.P. NEW DOXFORD OIL ENGINE

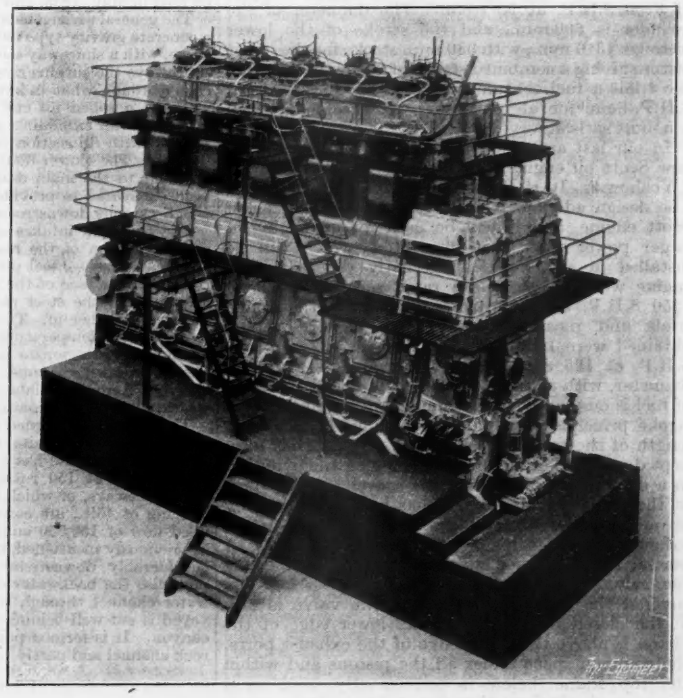


FIG. 12—1250 S.H.P. BISCOTT OIL ENGINE

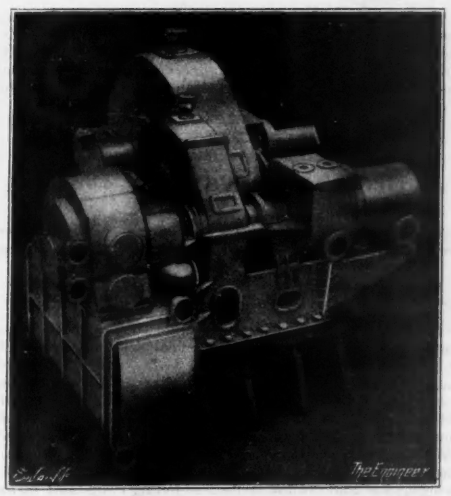


FIG. 13—MODEL OF PARSONS "SIMPLEX" TURBINE UNIT

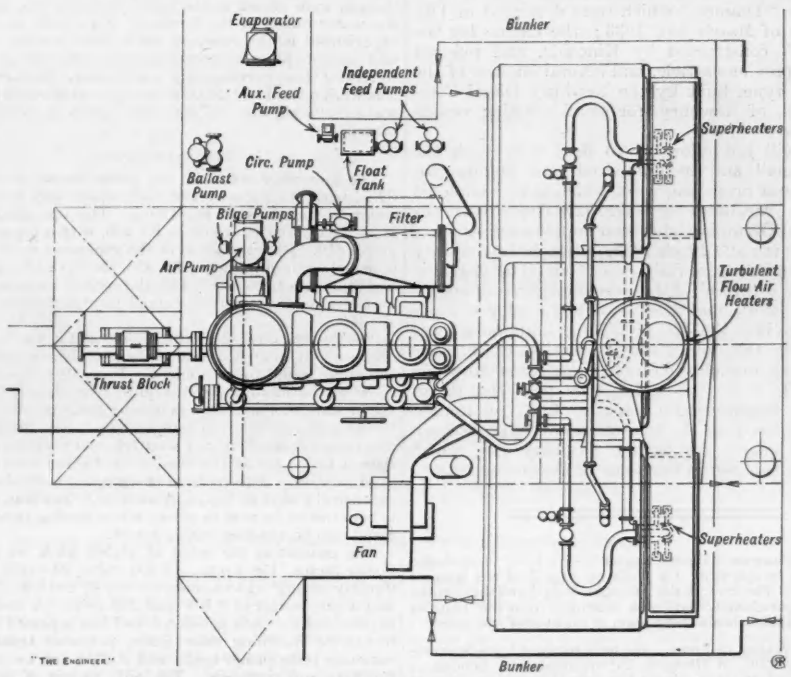


FIG. 14—MACHINERY ARRANGEMENT, S.S. "ARCWEAR"

With the propelling machinery fitted in a ship 360ft. long, 57ft. 6in. beam and of about 7000 tons deadweight carrying capacity, it is expected that consumptions of 21, 16, and 11½ tons of coal per day for corresponding speeds of 11, 10, and 9 knots in a loaded condition will be obtained. These estimated figures were, we understand, borne out in the recent trial, and further records are to be taken in the later loaded trials and on the first voyage of the ship.

As Figs. 10 and 14 show, the propelling equipment comprises a single improved triple-expansion steam engine, so arranged that a high all-round economy is attained with good accessibility to all parts of the installation and easy operation. The engine shown in Fig. 10 has a 21½in. diameter high-pressure cylinder, a 37in. intermediate-pressure cylinder, and a 62in. low-pressure cylinder, with a common stroke of 62in. The designed trial output is 1750 I.H.P. when supplied with superheated steam at 220 lb. pressure, and working with a 26in. vacuum. Features of the engine design include the double-beat poppet valves on the high-pressure cylinder, the Martin and Andrews balanced slide valves of the intermediate-pressure cylinder, and an ordinary flat, double-ported slide valve on the low-pressure cylinder. The poppet valves are cam-operated, and the valve gear for the other cylinders is of the Stephenson pattern, with a reversible turning engine, and hand-barring arrangements. The engine-driven pumps and the auxiliary pumps incorporate the latest marine practice. Steam is supplied by two single-ended cylinderical boilers, each 13ft. 6in. diameter and 11ft. 6in. long, working under forced draught conditions. There is also an auxiliary boiler, 12ft. diameter, with a length of 10ft. 6in., which works under natural draught and can be coupled up to the main installation if so desired. The working pressure is 220 lb. per square inch, with a final steam temperature of 630 deg. Fah., which is obtained in the latest type of North-Eastern superheaters. An improvement in the boiler-room has been effected by grouping all the valves and fittings usually placed above the boilers on the engine-room side of the bulkhead. They are easily accessible and, further, allow control of circulation and temperature conditions without leaving the engine-room. The air heaters are of the Howden turbulent flow pattern. The propeller is of the Manganese Bronze and Brass Company's Scimitar type, with a streamlined boss and a cone fitted over the propeller nut. Its blade sections are of a special form, and when tested with the model of this hull, it gave a particularly high propulsive efficiency. This was borne out during the recent trials.

Oil Engine Progress.

The outstanding oil engine of the past year was undoubtedly the new Doxford opposed-piston engine, with welded frames. The new design, which was prepared and carried out under the personal supervision of Mr. K. O. Keller, has given an engine which is 7ft. shorter than the earlier type of engine, with a much greater rigidity of structure and a saving in weight of close upon 50 tons. Fig. 11 shows one of the engines built for the two Reardon Smith cargo liners, the "Devon City" and "Houston City." They are four-cylinder units with a designed output of 3200 S.H.P. at 95 r.p.m. The diameter of the cylinder is 600 mm., and the stroke of the lower piston is 1340 mm., with 980 mm. stroke for the upper piston, giving a combined stroke of 2320 mm. During the trials a fuel consumption of 0·355 lb. of oil per S.H.P.-hour for all purposes was obtained, which is a most satisfactory result.

In our last article we made brief reference to the new Scott oil engine, designed for the motor vessel "Yochow." It is illustrated in Fig. 12 herewith. The design adopted is a development of the earlier Scott engine, and it will be used for an engine of larger power than that illustrated, which will be installed in a motor ship recently ordered. The engine we illustrate has a rated service output of 1250 S.H.P. at 116 r.p.m., but during the bench trials and measured mile trials higher outputs obtained were 1660 S.H.P. at 144 r.p.m., and 1560 S.H.P. at 125 r.p.m. The five cylinders are 22in. diameter, with a stroke of 36in., and airless injection of fuel is employed, the engine operating on the two-stroke principle with port scavenging. The overall length of the engine is only 27ft., and this has been kept down to a minimum by arranging the cylinders in a continuous group with the scavenge pump unit at the forward end. Height has been conserved by the adoption of a new form of rotary valve in the exhaust outlets, which runs at engine speed. A partial supercharging effect is obtained by causing the valve to close when the rising piston has just covered the scavenge ports. As the valve is also in the closed position when the lower edge of the piston is above the lower edge of the exhaust ports, the common space under all the pistons and within the top frame below is conveniently used as a scavenge air receiver, thus dispensing with the usual external main. The use of an engine-driven valve in the exhaust outlet has enabled very short pistons to be used, generally similar to those employed in the four-stroke engines, and the long skirts which are usually associated with two-stroke pistons have been dispensed with. The engine has several small improvements in the arrangement of the controls and manœuvring gear, and no reversing engine is required.

There was a considerable increase in the use of pressure charging during the year, and examples of engines so fitted included the 5000 B.H.P., four-stroke engines built by Vickers-Armstrongs for the submarine "Thames," which were described in THE ENGINEER of March 3rd, 1933; the engine for the "Malaita," constructed by Kincaids, and referred to in our previous article, and several engines of the "Sirron" type, built by the Newbury Diesel Company, Ltd., of Newbury, for small coasting vessels and barges.

Space will not allow us to deal fully with the various small and medium-sized new engines for auxiliary and propelling work which were completed during the year, but our readers may be referred to our two special Olympia Exhibition Supplement issues of September 8th and 22nd, 1933, in which the majority of these engines were fully described. The year was marked by a revival of the horizontal type of engine for marine work, and a 500 B.H.P. Crossley-Premier engine driving B.T.H. propelling equipment was supplied for the double-ended ferry boat "Electric Star," which is employed on the Hong Kong–Kowloon service. Towards the end of the year the Brush Electrical Engineering Company, Ltd., of Loughborough, placed on the market a new type of horizontal oil engine for marine auxiliary use, which was fully described in our issue of December 29th.

GERMAN CRUISER "DEUTSCHLAND."—We have to apologise for an error in the title of a block on page 5 of our issue of January 5th. The lower of the two engravings shows the German cruiser "Deutschland" and was reprinted from our issue of June 23rd, 1933, when a description of that vessel was given.

FLOW OF WATER IN PIPES.—We have received from Stewarts and Lloyds, Ltd., of Glasgow, Birmingham, and London, a valuable series of tables giving the flow of water in pipes of various diameters at various inclinations. The tables constitute a supplement to the company's catalogue, section Z, giving the capacities and properties of steel tubes, and replace the corresponding tables of that section. The earlier tables were calculated in accordance with the standard formula of the time which made the head lost in friction a function of the square of the velocity of flow and of the first power of the bore. Recent experimental work has led to the establishment of more accurate and more complicated formulæ for the flow of water in pipes. The tables have therefore been recalculated, the basic formula used for the purpose being a simplification of the new formulæ and being based on a relationship which makes the head lost in friction a function of the velocity of flow raised to the 1·85 power and of the diameter of the bore raised to the 1·15 power. The tables are divided into sections applicable to new coated steel or cast iron pipes and to bitumen-lined pipes. They cover pipes ranging from 1in. to 84in. in diameter at slopes ranging from 1 in 5 to 1 in 6000.

Abitibi Canyon Power Development.

THE Abitibi Canyon development, great Northern Ontario water power project, recently taken over and now being completed by the Ontario Hydro Electric Power Commission, is situated on the Abitibi River in the James Bay drainage area, about 70 miles north of Cochrane. The site possesses natural advantages for the construction of a power development, in that the river channel at this point is confined to a narrow gorge, the rock walls of which rise some 150ft. above the river bed. Work on this project was started in the spring of 1930. The first unit was placed on load in May, 1933, and the second unit in August.

The general arrangement of the development consists of a concrete gravity type dam across the main section of the gorge, with a sluiceway section on the east side. From the sluiceways the surplus river flow is conveyed to the lower river through what is known as the high-water channel. There is a rolled fill embankment with a long concrete retaining wall extending west from the main dam, and a similar earth fill section running east from the sluiceway section. The power-house is in the gorge immediately adjacent to the main dam section, the river bed having been excavated to provide a satisfactory tailrace channel which extends downstream for a distance of some 1500ft.

The penstock intakes are in the upper portion of the gravity section of the main dam, feeding through racks and head gates. Steel plate penstocks, 18ft. in diameter, run down the face of the dam to the power-house, where they join to the steel plate scroll cases of the turbines incorporated therein. These penstocks are protected from extreme low temperatures by a continuous roof which extends over the entire penstock area. This roof is supported on steel columns, and consists of I-beam purlins carrying Aerocrete slabs, which are protected from the weather by a heavy coating of gunite.

The station is designed and constructed for an ultimate installation of five units, two of which are now complete. Each of these units has a rated capacity of 66,000 brake horse-power at 150 r.p.m., under a net head of 237ft. The sluiceways, of which there are five, each with a clear opening of 45ft., are capable of discharging a maximum flood flow of 150,000 cubic feet per second, all of which, as previously mentioned, is conveyed to the river at a point considerably downstream from the plant, in order to minimise the backwater effect in the tailrace. The high-water channel through which these flood flows are conveyed is cut well behind the edge of the east bank of the canyon. It is formed partly through the excavation of a rock channel and partly by concrete wall sections.

CONSTRUCTION.

Actual construction was started towards the end of 1930. The first work to be undertaken consisted of driving two unwatering tunnels to carry the river around the site. Concurrently foundations were placed for a temporary double-track steel railway bridge across the canyon. Both the tunnels and the bridge were completed in the spring of 1931. Cofferdams were also constructed during the winter months below the south and above the north portals of the unwatering tunnels and work was started on the power-house and dam excavation.

Concreting for the dam was started in the autumn of 1931, and was completed for the most part by the following spring. It included the placing of the concrete in the sluiceway, retaining walls, and high-water channel walls. The closure gates at the upper portals of the unwatering tunnels were closed in the early part of June, 1932, and the water raised in the forebay. Very little trouble was experienced in the carrying out of this forebay flooding, and concrete plugs were subsequently placed in the tunnels to render them permanently water-tight. In carrying out this work a total of 1,240,000 cubic yards of earth and rock was excavated, and 527,000 cubic yards of concrete were placed.

SUPERSTRUCTURE.

The generator room in the power-house is 225ft. by 52ft., with the units spaced 45ft. apart and mounted on concrete pedestals at El. 429·5. The operating gallery is on the downstream side at El. 420, with a piping gallery at El. 410. Directly south of the generator room are four floors, the pump tunnel at El. 420, the 13·8-kV equipment and station service at El. 432, the control room and offices at El. 455, and a piping tunnel for the transformers at El. 469.

The power-house roof is at El. 480 and it was considered necessary to apply a special roofing, as there would be considerable traffic to equipment. It is also expected that snow will accumulate and require shovelling. The usual tile or slate roof surface was not deemed practicable owing to the wide variation in temperature. A wearing surface was therefore applied over a tar felt roof covering. It consists of 1in. of tar and crushed stone dressed with a tar and sand mixture. This method of surfacing is similar to that extensively used in road surfacing or retreading, and as it is believed to be new to power-house roofing practices the result will be watched with interest.

The generators are rated at 48,500 kVA, 85 per cent. power factor, 150 r.p.m., 13,800 volts, 25 cycle, and are directly connected to a main exciter of 180 kW, 250 volts, and a sub-exciter of 7 kW and 250 volts. A steel cubicle is provided for each generator and has separate compartments for incoming main leads, potential transformers, outgoing transformer leads, and station service supply oil breakers and potheads. The only means of isolating a generator from its transformer bank are single-pole, hand-operated disconnecting switches. The main leads between the generator and its cubicle consist of two ¼in. by 4in. copper bars per phase supported on 23-kV insulators in a horizontal cell structure immediately below El. 432. Louvres in the downstream wall supply outside air to an enclosing steel shield around each generator. The air is forced through the machine from the top, passing through steel ducts below and may be exhausted either inside or outside the generator room through other sets of louvres.

MAIN TRANSFORMERS.

The connections between the cubicle and the transformer bank are made with 1,500,000 cir. mils stranded copper cable, paper insulated and lead covered. There are three cables per phase, each approximately 70ft. long. The transformers are installed on the roof—see illustration on page 72—and each bank has three 16,000-kVA, 13,800 delta/-132,000-volt star-connected water-cooled transformers. An openly constructed copper bar low-voltage delta bus is installed close to the low-voltage bushings. Because of the great changes in temperature during the year it was decided to add expansion joints between the cable potheads and the delta bus-bars. A set of high-voltage lightning arresters is installed directly south of each transformer bank.

HIGH-VOLTAGE SWITCHING.

There are two ring busses, each with five oil circuit breakers and each being fed from two units and supplying two lines. Bank No. 3 may be connected by motor-operated disconnecting switches to either ring bus or may be split between the two. The station service is normally supplied by a three-phase, 450-kVA, 13,800/550-volt transformer with an automatic tap-changing device having eight-high voltage full capacity taps approximately 2½ per cent. for full kVA capacity below normal voltage. As a standby there is also installed a 500-kVA, 550-volt service generator, water-wheel driven. A standby motor generator exciter set, consisting of a 270 H.P., 550-volt induction motor, and a 180-kW, 250-volt shunt-wound generator, is provided with suitable switching so that it may replace any direct-connected main exciter in case of failure.

The system incorporates an interesting scheme of automatic supply of 13,800-volt generator power to the service bank. This supply may be from either generator of pairs 1, 2 or 4, 5. For each of these pairs an electrically operated disconnecting switch is connected to the generator bus at the cubicles with the transformer sides connected in parallel to an oil circuit b eaker. The transformer sides of the two oil breakers are also connected in parallel to the service bank. The pair of breakers are electrically interlocked so that either cannot be closed if the other is in the closed position. An auxiliary switch on each breaker prevents either of the pair of associated disconnecting switches from being opened or closed electrically while the breaker is closed. Each pair of disconnecting switches is also electrically interlocked to prevent the closing of either one when the other is closed. In case of a shut-down owing to relay operation of the main generator to which the station is connected—for example, generator No. 1—the station service breaker No. 1 would open and breaker No. 2 would close, connecting the station service to generator No. 4 or No. 5, depending on which set of disconnecting switches is closed. This throw-over scheme will be inoperative if the station service generator breaker is closed, or if the breaker has been tripped owing to the operation of the over-current relays. Suitable under-voltage relaying on service feeders prohibits trip out for low voltage during the short interval between the opening of one breaker and the immediate closing of the other.

SWITCHBOARDS.

The control room is at the centre of the power-house, with the main vertical switchboard shaped like five sides of an octagon. The centre section is a five-panel main control and indicating meter board, one panel for each main unit. To the east of the main switchboard is a generator relay board of seven panels with a battery distribution switch panel with automatic emergency lightning throw-over switching and a small panel for the service generator field switch at the right. All panels are of the stretcher steel except the latter two. The high-voltage bus and line relays are installed on a five-panel board placed in a small room beneath the high-voltage breaker platform.

The original plant was designed by Mr. George F. Hardy, Consulting Engineer of New York City, and the construction work was carried out by the Dominion Construction Corporation, Limited, for the Ontario Power Service Corporation, Limited, former owners of the development.

The above article is based on information compiled for the Ontario Hydro Electric Power Commission by J. R. Montague, of the Hydraulic Department, and G. H. Bradshaw, of the Electrical Engineering Department, and the photographs were supplied through the courtesy of the Commission.

British Railways in 1933.

BY the continued courtesy of their civil engineers we are enabled to give the following report of the engineering activities of the British railways during the past year.

London, Midland and Scottish.

Works Completed.—The following works, which were mentioned in our report for the year 1932—on page 39 of the issue of January 13th, 1933—were completed during the past year:—New station at Leigh-on-Sea, opened on January 4th, 1934; new station at Chalkwell, between Leigh-on-Sea and Westcliff; Dagenham Dock new goods depôt; new station at South Kenton, opened July 3rd; remodelling of motive power depôt, Nuneaton; Cheadle Branch deviation, completed November 26th; Bromsgrove and Stoke Works widening; up and down loops, Hazel Grove; new station at Besses o' th' Barn.

Works in Hand.—The new down loop at Laindon, on the London and Southend line, which is to enable trains to start from and terminate at that station, approaches completion. The new carriage siding at Shoeburyness has been brought into use and the remodelling of the locomotive yard is nearly finished.

Works Begun.—In order to serve the housing developments which are taking place in that vicinity, a new station, to be served by the two electrified lines, is being constructed between Hornchurch and Upminster. It will be known as Upminster Bridge.

The viaduct at Sharnbrook, near Bedford, which was rebuilt in 1881, when the Irchester-Sharnbrook deviation was opened, consists of ten spans of varying lengths. The floor under the two passenger—the original—lines is being replaced by a steel floor, welded to the top flanges of the existing main girders. Four spans have been completed and work on five others is in hand.

The lay-outs of the locomotive running sheds at Rugby, Monument-lane, Walsall, Aston, Springs Branch, Edge Hill, Prescot, Longsight, Lancaster, and Farnley are being improved and mechanical coaling plants and ash disposal plants installed. These works are part of a programme for the modernisation of running sheds which will permit of a much quicker turn-round of the locomotives at the sheds and their consequent increased employment in traffic.

London and North-Eastern.

Works Completed.—The following works, mentioned in our report a year ago, were completed during 1933:—Reconstruction of the locomotive depôt at King's Cross; all-electric signalling at King's Cross; Gidea Park and Shenfield widening, opened on January 1st, 1934; York and Northallerton widening and provision of colour-light signalling, completed on November 30th; reconstruction of Parkgate Bridge, Darlington, and of Bridge No. 47 on the Whitby branch; new locomotive depôt, Thornton.

Works Progressing.—About 90 per cent. of the work in connection with the new down marshalling yard between Dinting and Mottram has been completed.

Of the extensions at Parkeston Quay, the lengthening of the existing quay, in reinforced concrete, and the approach viaducts have been completed; about 30 per cent. of the new station and other building on the extension has been finished and it is hoped to finish the enlargement of the existing goods marshalling yard in three months' time.

New Works Begun.—The reconstruction of Fenchurch-street Station, in order to permit of considerable acceleration and augmentation of the passenger train service, which has been started, involves comprehensive alterations to the running lines between that point and Leman-street Station, as well as the reconstruction of station buildings and platforms. Colour-light signalling is to be installed.

It is proposed to reconstruct the trawl dock at Lowestoft Harbour, and during the past year the west quay was rebuilt in reinforced concrete.

Water softening plants are being installed and others are under consideration. Those in hand on the Southern Area are at Bawtry, Redbank, Doncaster, Newark, Offord, and Retford.

A portion of the wagon shops at York was recently destroyed by fire. It is being replaced by a shop, 710ft. by 151ft., and, additionally, further accommodation, to the extent of 12,210 square feet, is being provided. The lay-out of that section of the shops is being reorganised in order to facilitate the rapid handling of repairs.

The shops at North-road, Darlington, are being reorganised and, in the process, a considerable amount of construction work is being carried out. A new engine weigh-house is to be built and six new engine pits, of a total length of 400ft. A joiners' shop, 112ft. by 40ft., is now being erected.

A station was opened at Monkseaton on the Tyneside electrified line early in the year. It was erected in a month, so the buildings are only of a temporary character. Permanent overhead structures are about to be constructed.

Great Western.

Works Completed.—Most of the important works which, during our last two annual reviews, have been recorded as in hand were completed during the year. They include the enlargement of Paddington Station, practically finished; the additional running lines through the stations between Didcot and Swindon, and a new marshalling yard at Swindon; quadrupling of the line between Filton Junction and Stapleton-road and between Pylle Hill and Portishead Junction; widening between Olton and Lapworth.

The improvements at Cardiff General Station are practically completed, with the exception of the main station buildings.

The work in connection with the 20-ton wagon scheme at the South Wales ports is well advanced. The work still in hand includes the construction of new fixed hoists at Cardiff and Barry and of a movable hoist at Swansea.

New Works Begun.—The present creosoting depôt at Hayes is fifty years old, and is being replaced by a modern plant. This has necessitated the tipping of some 30,000 yards of filling material to bring up the levels of the new depôt.

The Minehead branch is being improved; the single line between Dunster and Minehead is to be converted to double track and two additional passing places are to be provided on the single line between the junction with the main line at Norton Fitzwarren and Dunster.

Southern.

Works Completed.—Two of the undertakings mentioned in our annual article of a year ago were completed during the year. They are the reconstruction of Queen-street Station, Exeter, which is now known as Exeter Central—opened on July 1st—and the new locomotive shed and depôt at Hither Green, finished in September.

Among the works begun and completed during the year is an additional station at Berrylands, between Malden and Surbiton, which was opened in October. The stations at Brixton, West Croydon, Wallington and Hounslow were improved or enlarged.

Works Progressing.—The enlargement of the locomotive depôt at Longhedge, to permit that at Battersea to be closed, approaches completion. A new coaling plant is being erected.

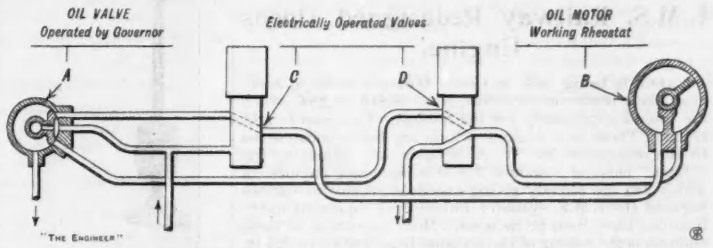
Works Begun.—The improvement of Dartford Station, including the provision of luggage lifts, is in progress. The station at Tonbridge is being reconstructed so as to allow for the curvature of the London-Dover main line to be improved and for the existing speed restriction to be relaxed. An additional loop line is to be provided on the up side, which will serve the up platform, for which purpose the latter will be converted into an island.

Construction of the berth at Dover for the new Dover-Dunkirk train ferry has been taken in hand. It consists of a wet dock with gates of the box type, and includes the necessary pumping plant and a mooring jetty. The scheme also provides for a transit shed for H.M. Customs, a station building with full accommodation for passengers, the examination of baggage, motor cars, &c. The Clarence Quay is to be enlarged, the permanent way rearranged and necessary berthing sidings provided.

The Southampton West Station is being reconstructed and enlarged. An overbridge is to replace the public road level crossing at the east end of the station. When completed, the new station will have four platform lines and a bay on the down side.

London Passenger Transport Board.

A year ago the Cockfosters Extension had reached Arnos Grove. In March last it was extended to Enfield West and the line was opened throughout on July 31st.



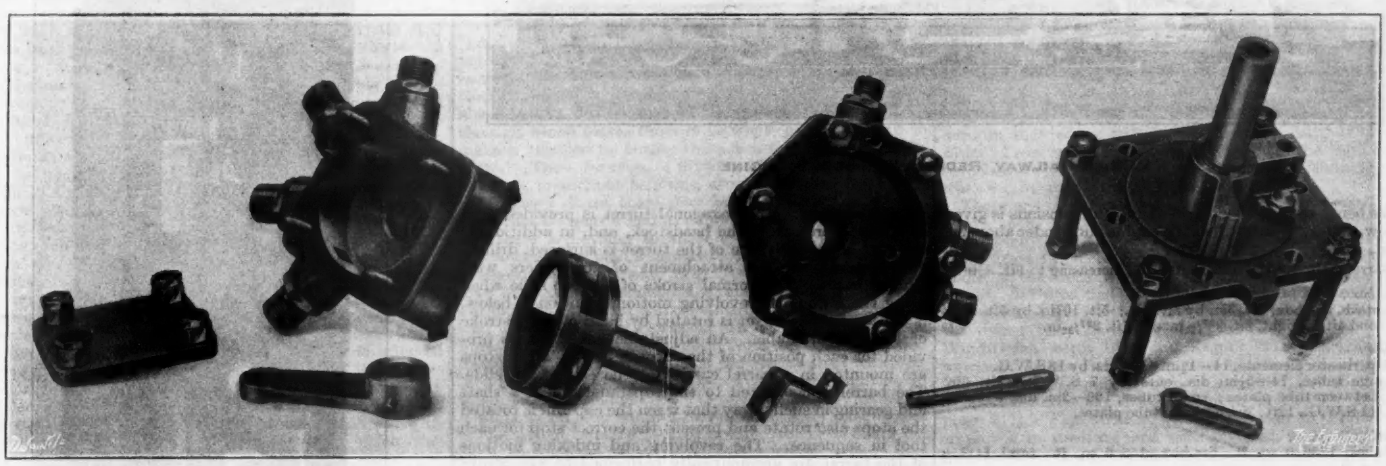
ARRANGEMENT OF CONSTANT HORSE-POWER CONTROL

The British Museum Station on the Central London has been combined with the Holborn on the Piccadilly line; Dover-street Station on the latter line has been displaced by a new one at Green Park; and a new subway, with escalators, joins the Monument Station of the former Metropolitan and Metropolitan District Joint Railway to the Bank Station of the Central London.

Three works which were not begun a year ago were also completed:—The Malmesbury branch has been abandoned as between the Swindon-Bath main line at Dauntsey and Little Somerford and connected instead to the Swindon-Badminton main line at Little Somerford. A new pier at Weymouth was opened and the reconstruction of the old pier practically finished. Additional sidings at Soho, Birmingham, to hold 292 wagons, also increased yard accommodation.

Works Progressing.—The extensive alterations and improvements at Temple Meads, Bristol, advanced satisfactorily. Several of the new platforms approach completion and the subways are progressing. The four new running lines between Dr. Day's Junction and South Wales Junction—the latter is at the eastern entrance to Temple Meads Station—are in hand.

The Carron timber viaduct on the Falmouth branch having been replaced by a masonry arched structure and the Ringwell viaduct substituted by embankments and a culvert, the College Wood viaduct—the only remaining timber viaduct on the branch—is being replaced by an arched structure built alongside the existing one.



PARTS OF OIL VALVE AND OIL MOTOR OF ARMSTRONG CONSTANT HORSE-POWER CONTROL GEAR

Constant Power Control for Oil-Electric Locomotives.

EARLY forms of automatic control for oil-electric vehicles took the form of the "decompounded generator"—that is, a generator with windings such that with heavy currents the voltage falls away to zero. It is possible to design the windings so that the product of volts and ampères at no point over the whole current range of the machine shall exceed a desired value, corresponding to the rated horse-power of the engine. Unfortunately, it is at one point only on this current curve that the rated horse-power of the engine is at all fully employed and though this can be improved by complications in the motor control equipment, the result, considered over a journey from start to stop, and up hill and down dale, is a poor utilisation of the available engine power.

In view of this serious limitation of the decompounded generator form of control, Sir W. G. Armstrong Whitworth and Co., Ltd., set themselves, three years ago, to the perfection of a scheme of automatic constant horse-power control.

Different media—electricity, compressed air, vacuum, and hydraulic (using the engine lubricating oil pressure supply)—were carefully investigated, and tested on the engine test bed. The hydraulic system was found after careful experiment to be the simplest, most reliable, and most easily maintained. It gave the control within the fine limits desired, and the bug-bear of all automatic control systems—hunting—was finally eliminated. Oil had the advantages over the other media mentioned of having its source of pressure conveniently situated, *i.e.*, on the engine itself; of allowing the control to give instantaneous response to the varying conditions of train speeds, gradients, &c., and of easy maintenance of parts owing to the lubricating qualities of the medium used.

One of the greatest advantages claimed for the Armstrong Whitworth system is that it does not depend upon definite movements which would entail very careful maintenance. It is self-adjusting against wear and leakage of oil, and against varying conditions of the temperature of the oil, and of the main generator and other apparatus. The apparatus was fitted to the oil-electric motor coach "Tyneside Venturer," then undergoing works' running tests, and was pronounced suitable in every way for the duties it had to perform. It was later used on shunting locomotives in 24-hour per day service, and is now in fact standard for all Armstrong-Sulzer rail vehicles. Light railcars and locomotives employing the Armstrong-Saurer variable-speed, commercial-vehicle oil engine and fitted with the A.B.E. simple transmission, do not, however, require this type of control.

The main features are shown in the accompanying diagrammatic sketch above, and the two items of the equipment are illustrated by photographs, reproduced below. By means of an oil valve A, shown at the left of the illustration, oil under pressure is admitted to one or other side of an oil motor B, seen to the right of the illustration. The oil valve is mechanically connected to the engine governor, and responds to any slight change in the position of the governor, while the oil motor is mounted at the back of a rheostat and directly coupled to the rheostat spindle; this rheostat controls the voltage of the main generator, from zero when the vehicle is starting from rest, up to the maximum voltage when the vehicle is travelling at its full speed.

There is, of course, a certain position of the governor corresponding to full rated fuel admission; any slight overload causes a fall of this governor position and a slight underload causes a rise. These small movements are transmitted to the oil valve, which then admits oil from the central pipe shown to the one immediately above or below (the pipe leading vertically down from the bottom of the valve is merely an oil drain back to the sump). The rotor of the oil motor responds to pressure in either of these pipes, turns in the required direction, and takes load off the engine, or puts additional load on, by lowering or raising the voltage of the generator. This is immediately answered by the return of engine speed to normal, the ports in the oil valve close, and the oil motor stays in its new position until some further change takes place in the train speed caused by meeting an up or down gradient.

The Armstrong-Sulzer engine is designed with two or

more normal running speeds, corresponding to full load, three-quarter load, &c., and change in engine speed is effected by control of the governor spring pressure. The position of the governor itself, therefore, remains the same at whatever speed the driver selects, and the automatic control, consequently, functions in exactly the same manner as described and maintains the engine at full, three-quarter, or whatever power has been chosen.

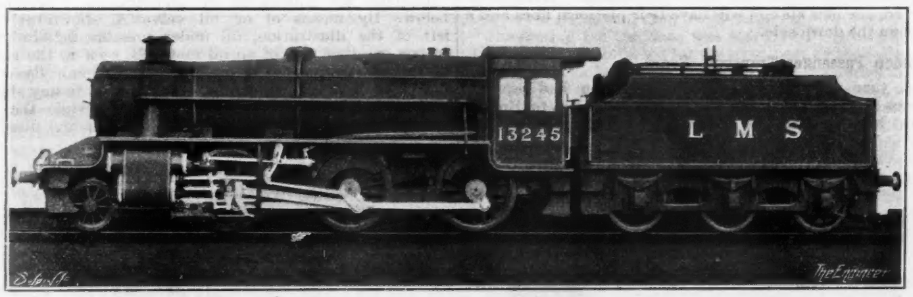
The two electrically operated valves C and D, seen in the diagrammatic sketch, provide what may be termed supervisory control. As shown in the diagram, these valves are de-energised; the dotted lines show the oil circuits in normal operation, when both valves are energised. The valve 4 prevents the rheostat from moving forward too fast at the moment of starting the train. It will be realised that, in addition to limiting the voltage on account of engine output, it is also necessary to limit the voltage at the moment of starting to prevent an excess of current slipping the wheels. This is effected by means of a current limit relay acting through valve 4. Valve 3 is normally energised when the train is in motion, but when the driver cuts off power this valve is de-energised and causes the rheostat to move right back to the zero voltage position ready for the next train start.

L.M.S. Railway Redesigned Goods Engine.

THERE is being built at Crewe Works a series of forty new 2–6–0 tender locomotives, Nos. 13,245–13,284, which are intended primarily for the haulage of express freight trains. These new engines, which are being constructed to the designs of Mr. W. A. Stanier, are similar to the "1300" class of standard 2–6–0 superheater engines, of which 245 are already giving excellent service in various parts of the L.M.S. system; but several important modifications have been introduced. Most important of these changes is the raising of the pressure from 180 lb. to 225 lb. per square inch. Consequently, the two cylinders are correspondingly reduced from 21in. by 26in. stroke to 18in. by 28in. stroke, and can be placed horizontally instead of inclined. The tractive effort is very little different, being now 26,288 lb., as against 26,580 lb. formerly. The boiler is of the tapered type, and has a heating surface of 1411 square feet, 1256 square feet in tubes, and 155 square feet in the fire-box, while the superheater, designed for moderate steam temperatures, has an area of 193 square feet. The grate area is 27·8 square feet.

The driving wheels are 5ft. 6in. in diameter, and the coupled wheel base is 16ft. 6in. The total length of engine and tender over buffers is 59ft. 10¾in.

The engine weighs in working order 65 tons, and with a standard six-wheeled tender having water and coal capacities of 3500 gallons and 5 tons respectively, the total weight in working order (engine and tender) amounts to 107 tons 4 cwt., the weight on each of the three coupled



L. M. S. RAILWAY REDESIGNED GOODS ENGINE

axles being 18 tons 10 cwt. A table of dimensions is given below, and a "portrait" of the engine and tender above.

Boiler;
Barrel, 11ft. $10^{1}/_{16}$in.; dia. outs. 5ft., increasing to 5ft. 8¾in.

Fire-box;
Outside fire-box, 9ft. 3in. by 8ft. 9in.; 5ft. 10⅞in. by 5ft. 2⅛in. and 4ft.; height, 8ft. $9^{27}/_{32}$in. and 7ft. $2^{27}/_{32}$in.

Tubes;
Superheater elements, 14—1⅜in. dia. outs. by 13 S.W.G.
Large tubes, 14—5½in. dia. outs. by 7 S.W.G., 12ft. 3in. between tube plates; small tubes, 160—2in. dia. outs. by 11 S.W.G., 12ft. 3in. between tube plates.

Heating Surface;
Tubes, 1256·0 sq. ft., fire-box, 155·0 sq. ft., total 1411·0 sq. ft.
Superheater, 193·0 sq. ft.

Grate Area;
27·8 sq. ft.

Tractive Effort at 85% B.P., 26,288 lb.
Weight loaded: Engine, 65 tons, tender 42 tons 4 cwt.; total weight of engine and tender, loaded, 107 tons 4 cwt.

Capstan Lathe with Single Pulley Headstock.

THE lathe illustrated herewith is a single-pulley, or individually motor-driven, high-speed machine, suitable for either chuck work or production from bars up to 1½in. diameter. It is a new production of H. W. Ward and Co., Ltd., of Birmingham.

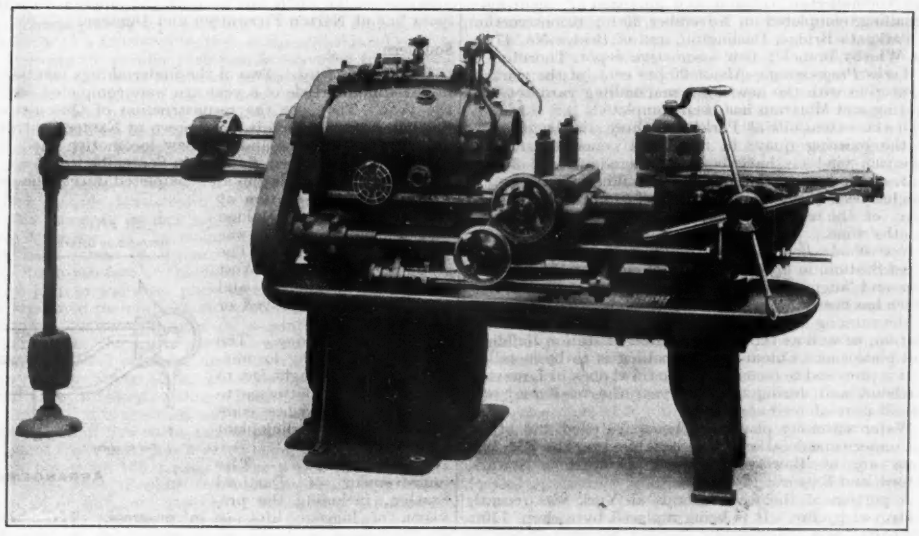
The headstock is of a new type allowing fast speed-changing through friction clutches which run in oil. Six spindle speeds in each direction are available, these speeds being arranged in three groups in such a way that two forward and two reverse speeds are obtainable without the necessity of moving gears. The low-speed group covers steel or cast iron work, the medium group such work as that on gun-metal castings, &c., and the high range, small bar work or high-speed drilling and work on aluminium and similar materials. The required range is obtained by the partial rotation of a lever on the front of the headstock, which operates sliding gears. An automatic brake of the internal expanding type is provided, and is operated by a cam in such a way that from any speed the spindle is brought to rest almost instantaneously by moving either of the two clutch levers to its central position.

The spindle is mounted on combined ball journal and thrust bearings, and has a 1⅛in. clear hole throughout its length. The automatic chuck enables bars up to 1¼in. in diameter to be handled. The single pulley is mounted on ball bearings carried in a bracket attached to the headstock, the object being to relieve the spindle of the belt pull. The sliding saddle and cross slide are operated by hand wheels. The longitudinal motion is obtained through a rack and pinion, and five stops are provided which can be used in either direction. The cross slide is also provided with dual stops in each direction.

The capstan rest can be clamped to the bed in any desired position. The hexagonal turret is provided with tool holes bored from the headstock, and, in addition to the tool holes, each face of the turret is surfaced, drilled, and recessed for the attachment of toolholders with flanged bases. The normal stroke of the top slide when using the automatic revolving motion, mentioned below, is 8in., but if the turret is rotated by hand a useful stroke of 11in. is obtainable. An adjustable screw stop is provided for each position of the capstan head. These stops are mounted in a barrel carried at the end of the slide. The barrel is connected to the capstan through a shaft and gearing in such a way that when the capstan is rotated the stops also rotate and present the correct stop for each tool in sequence. The revolving and indexing motions of the turret are automatically performed on the return stroke of the capstan slide, but an arrangement is provided whereby these motions can be rendered inoperative at any time. Automatic feed is applied to the capstan slide from a shaft running along the front of the machine and transmitting to a gear-box attached to the capstan rest. Four rates of feed are obtainable, the feeds being tripped automatically or by hand.

The automatic chuck, which is fitted when the lathe is intended for bar work, is self-contained, and allows the machine to deal with material up to the full diameter of the hole through the spindle. The chuck is operated by a single lever, which is used for both gripping and releasing. All the mechanism is totally enclosed in a case, which is bolted to the front of the headstock, the rotating portion of the mechanism being attached to the flanged spindle nose. The whole chuck can be quickly removed from the machine, leaving the spindle flange free for the attachment of jaw chucks or face plates.

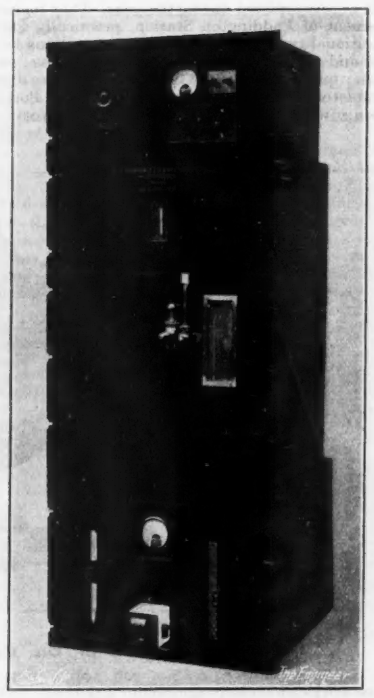
The following are some of the leading particulars of the machine:—Height of centres, 6½in.; spindle speeds (pulley at 500 r.p.m.), 42, 75, 137, 290, 450, 930; H.P. of motor required for average work, 4; total adjustment of saddle and cross slide along bed, 13in.; maximum distance between tool posts, 13½in.



WARD 6½IN. CENTRES CAPSTAN LATHE

Frequency Control.

IN the new system of European wavelengths introduced during the night of Sunday last, the Bournemouth and Plymouth broadcasting stations have been allotted the same wavelength, which involves the operation of the two stations at a frequency correct to within one part in a million. If the frequencies were allowed to drift apart, confusion would occur in receivers capable of picking up the transmissions of both stations which are, therefore, controlled by tuning forks of exactly the same frequency. Two valve-maintained standard tuning fork equipments, as shown in the accompanying illustration, have been supplied by W. H. Sullivan, Ltd., of Leo-street, Peckham, for use at these stations, each giving a frequency correct to 5 parts in 10 millions, and a frequency stability of 2 parts in 10 million. In order to obtain these extreme accuracies, the fork must vibrate under ideal conditions, and it is, therefore, mounted in a massive cast iron chamber evacuated and maintained at a constant pressure to within 0·5 mm. of mercury. As temperature also slightly affects the frequency of the fork vibration, the chamber is maintained at a constant temperature to within one-hundredth of a degree. The frequency of the forks is 1439·450 cycles per second, a multiple of which, *i.e.*, 1024 times, gives 1474 kilocycles, which is the frequency of the common wave allotted to the stations.



SULLIVAN TUNING FORK EQUIPMENT

GRADUATES' DANCE.—The third "joint" dance of the Graduate and Student Sections of the Institutions of Mechanical and Electrical Engineers and the London Students of Civil Engineering was held last Tuesday, January 16th, at Victoria Halls, Southampton-row. The function was a great success, there being over 400 persons present, among whom, as a guest, was Mr. Alan E. L. Chorlton, President of the Institution of Mechanical Engineers. This dance has now attained a position of great popularity, and it may confidently be expected to be an annual affair for many years to come.

The Reverberatory Furnace with Coal Fuel, 1612—1712.*

By RHYS JENKINS, M.I. Mech. E., Past-President.

INTRODUCTION.

IN the story of the application of pit coal for industrial purposes, particularly in the smelting of lead and copper, the reverberatory furnace plays an important part. It is the object of this paper to give some account of this phase of the history of that type of furnace. The available records on the subject are scanty, and it will be seen that the story is by no means complete; many points remain obscure, and much remains for farther research.

THE REVERBERATORY FURNACE WITH WOOD FUEL.

Before proceeding to our subject, it will be well to give a short *résumé* of what is known of the reverberatory furnace prior to the introduction of pit coal, when wood was the fuel employed. And first, as to our terms, the word "reverberatory" comes from the Low Latin "reverbero," to beat back; and to-day, by reverberatory furnace, we mean one in which the material under treatment and the solid fuel are kept apart and the flame and hot gases from the burning fuel enter the furnace proper at one end and deflected or beaten down on to the material on the hearth by the roof of the furnace. In earlier times the distinction that the fuel and the material under treatment are kept apart did not always obtain, and we find the term "reverberatory" applied also to a furnace consisting of a close fireplace with a dome-shaped cover adapted to throw back the flame and heat upon the object, such as a retort, resting above the fire. An example of the use of the word in this sense will be found in "The Laboratory," by G. Smith, 1740 (second edition), and in books of later date.

The earliest account of a reverberatory furnace known to the writer is that of the glass furnace given by Theophilus.[1] The exact date of his work is not known, but it seems likely that it was written in the eleventh century. Theophilus was a monk, and he wrote to instruct others who were engaged in the decoration of churches. The furnace he describes has a fireplace separated from the hearth by a bridge or dwarf partition wall; he does not suggest that it was a new construction; it was, no doubt, the form he had seen in use, and probably had been in use long before.

Glass technology seems to have been a thing apart, and we have a long interval before we learn of the use of the reverberatory furnace in other industries. Then, early in the sixteenth century we find it in use in parts of Germany by gun-founders for melting bronze, and in smelting works. Dr. Otto Johannsen, well known for his researches in the history of ironfounding, &c., takes its use in Germany for gun-founding back as far as the year 1486. A chronicle of that year announces that a gun had been cast at Frankfort without the aid of bellows and with wood as fuel. One would have wished the evidence to be a little more definite, but, accepting the view that the furnace was reverberatory, it is interesting to observe that, according to the chronicle, the man who cast the gun (he was a German) had learned the construction of the furnace in Turkey, and that he had served as gun-founder under the Emperor of that country.[2]

Some sixty years later another German gun-founder gives such a description of a reverberatory furnace that it has been possible to make from it a sketch. The sketch shows a fireplace separate from the hearth.[3] But before this Leonardo da Vinci had sketched a furnace with a separate fireplace, and the Italian writer Biringuccio had published his "La Pyrotechnie" (1540). Biringuccio gives us drawings of furnaces used in founding bronze guns and bells (unfortunately, they are not at all clear), and he mentions the use of such furnaces in smelting works in Germany; for the treatment of some ores he thought they were to be preferred to blast-furnaces.

It is somewhat remarkable that the classic work on mining and metallurgy, Agricola's "De re metallica," which was published in 1556, and embodies such an immense fund of information on German practice, does not mention the reverberatory furnace. One of his drawings does show a domed furnace for roasting ore in which the fuel is placed on one side of the hearth and the ore on the other, and the combustion is effected without bellows.

Another book remains to be mentioned—"Art de los Metales," of A. A. Barba, published in 1640. This deals with metallurgy in Spanish America, and describes, with illustrations, "el horno de reverberacion," which was used both for roasting and for melting ores.

COPPER SMELTING.

It is known that in the time of Queen Elizabeth, copper smelting works were started at Keswick, in Cumberland, and at Neath, in Glamorgan. A large part of the money spent in building and running these works was supplied by a German merchant firm, and the manager and expert workmen came from Germany. Fifty years or so ago some documents relating to this undertaking were printed. Among them was a letter relating to the Neath works, written in 1586 by Ulricke Frosse, one of the German experts, in which it is stated that pit coal as well as charcoal was being used.[4] That statement has been made the basis of an assertion that the reverberatory furnace was employed from the very beginning of copper smelting in South Wales. It is possible that Ulricke Frosse may have had this type of furnace, but the evidence certainly does not make it certain. As a matter of fact, it is clear from the account books of the Keswick works that from the year 1569 they were using pit coal, as well as peat, wood and charcoal,[5] but there is no need to assume that pit coal could be used only in the reverberatory furnace. We have seen that Agricola has an ore-roasting furnace in which the fuel and the ore are kept apart, the fuel on one side of the furnace and the ore on the other, and it is quite likely that this type of furnace may have been in use at Keswick and at Neath for roasting the ore. There were blast-furnaces, also, for in the Keswick accounts there are distinct references to bellows and to water-wheels for working them. But, although definite evidence is lacking, it is possible that the reverberatory furnace may have been in use, for even if Agricola is silent about it, Biringuccio does tell us of its use in smelting works in Germany. However, it is to be noted that the Neath works had a very short life—but a few years—and that the Keswick works were destroyed in the Civil War, soon after 1640.

THE COAL-BURNING REVERBERATORY FURNACE.

So far as the writer is aware, the earliest description in the English language of a reverberatory furnace is to be found in John Rovenson's "A Treatise of Metallica," published in 1613.

In 1611, King James I. granted to Simon Sturtevant a patent, the subject matter of which covers a wide range; for our purpose it will be enough to say that it includes the smelting of iron and other metals with pit coal. The inventor alleged that he had invented divers furnaces, hearths, &c., for that purpose. A condition of the grant was that within a specified time Sturtevant was to publish a specification. This was done, under the title "Metallica or the Treatise of Metallica," printed in 1612. In the same year, 1612, a patent was granted to John Rovenson, which likewise covered the smelting of metals with pit coal, and, like Sturtevant, Rovenson was required to publish a specifications of his invention. This he did in 1613 in the form of "A Treatise of Metallica," referred to above. According to Rovenson, Sturtevant's patent had been made void "by reason of his standing outlawed at the time of the grant."

When we come to study Sturtevant's treatise we find that he has very little to say of the construction of the furnaces that he alleged he had invented, and that that little is very obscure. However, it does come out that his furnace had one part for the material under treatment, another for the fuel, and a third for the ash, so that it would seem that he had some form of reverberatory furnace in view. We gather from what he says that he had not yet built a furnace.

Rovenson's treatise is more helpful. It has a section headed "The description of the furnace and fire-works, and additaments," in which he divides furnaces into two kinds, (*a*) furnaces "not of division, wherein the mettal or material lieth together with the fewell in one place undivided," and (*b*) "furnaces of division, wherein the mettal or material to be melted or wrought is kept divided from the fewell . . . so as no substance of the fewell, but onely the heat and flame thereof can touch the mettal or material." He goes on to say that the furnace may be "close on the top with some vent holes, and so merely [*i.e.*, purely or simply] reverberatory, the mettals or materials to be melted or wroght lying in the cisterne or hearth before it be melted, and is thereing melted, and then run forth." In another passage he says: "the fewell always lying on grates without the cisterne or hearth, through which grates the aire or winde gathereth, and so maketh the fire to burne, the ashes falling through the grate." These furnaces of division might be made "with bellowes, or without bellowes, as wind-furnaces."

Whatever doubt there may be about Sturtevant, it is clear that Rovenson had in mind a reverberatory furnace, but there is nothing to show that he, any more than Sturtevant, ever built a furnace, or did anything in the way of smelting with pit coal. Still it is likely that the project may have been considered a promising one at the time. Perhaps we may find some indication of this in the fact that when the Earl of Pembroke started ironmaking in the Forest of Dean, in 1612, his grant from the Crown included liberty to dig and take so much sea coal as shall be necessary for carrying on the works. This was in addition to wood, ore, and cinders.

Eight years later we find Rovenson's rights safeguarded in the patent (No. 15*, 1620) granted to Sir William St. John and others for smelting iron with pit coal; that grant is limited to smelting in open and plain furnaces, where the iron is mixed with the coal, and not in "the furnaces or fireworks of division of the said Rovenson's invention." And this is the last we hear of Rovenson.

In the course of the next sixty years or so we meet with quite a number of projects for smelting metals with pit coal. In some of these we know that charked coal, or coke, was employed; in others the reverberatory furnace with raw coal was tried. This seems to have been the case with Jeremy Buck's project. Buck obtained an Act of Parliament in 1651, for "Melting down Iron and other Metals with stove-coal and other coals, without charking." Dud Dudley, who was familiar with Buck's experiments, says of them: "which was done in spacious wind-furnaces, and also in pots of glass house clay," from which we gather that first he tried smelting in the reverberatory furnace and, next, in pots.

It is clear that Frederick de Blewston tried to smelt iron in the reverberatory furnace. He obtained a patent in 1677, and in Plot's "Staffordshire," which came out eleven years later, we are told:—

> "The last effort that was made in this country for making iron with pit-coal was also with raw coal, by one Mr. Blewstone, a high German who built his furnace at Wednesbury, so ingeniously contrived (that only the flame of the coal should come to the oare, with severall other conveniences) that many were of opinion he would succeed in it. But experience that great baffler of speculation shewed it would not be: the sulphureous vitriolic steams that issue from the Pyrites, which frequently, if not always, accompanies pit-coal, ascending with the flame, and poysoning the oare, sufficiently to make it render much worse iron than that made with char-coal, though not perhaps so much worse as the body of the coal itself would possibly doe."

It will be noticed that according to Plot's account the trouble was not with the furnace, but with the coal—it contained too much sulphur—and indeed we find Blewston, in 1681, applying for a patent for "Correcting all sorts of coal," so it would seem that a more or less satisfactory construction of coal-burning reverberatory furnace had been arrived at.

While Blewston was still carrying on his experiments in iron smelting the reverberatory furnace had been successfully applied on a commercial scale for smelting lead. The story is a confused one; put briefly it amounts to this:—In 1678 George, Viscount Grandison, obtained a patent for an invention "to melt and refine lead ore in close or reverberated furnaces with pit-coal." The invention was the same as that which had been patented two years before by Samuel Hutchinson. Grandison set up lead works near Bristol, by 1686, under cover of Hutchinson's patent, another works had been erected a few miles off; then Grandison complained that his workmen were being induced to leave him for the new works. It is reasonable to suppose that the second works would not have been started unless the furnaces used at the first had given satisfaction. The result of Grandison's complaint was that Hutchinson's patent was declared void by the Privy Council, and probably the second works then ceased operations. One of the partners in it, John Hodges, went to Ireland and set up lead works there. In 1690 he received an Irish patent "for melting & refining lead ore in close or reverberatory furnaces with pitt coale"; he stated in his petition that he had already introduced the invention into Ireland. There can be no doubt that the furnaces were the same as those used at Bristol. In 1692 a charter was granted to the Governor of the Company for smelting down lead with pit coal and sea coal. Probably the Company took over Grandison's works; at any rate in the following year they were advertising for lead ore to be delivered at their "works at the Cupsola near Bristol."

At about the same time as these lead smelting works were being built other men were trying to apply pit coal in the production of copper, and in 1697 Houghton ("Collections," No. 257) was able to announce that "we have lately found out the art of calcining the oar [of copper] with reverberatory furnaces and pit-coal."

In the same year Sir Humphrey Mackworth engaged to set up a "cupilo" on his property at Neath to smelt copper and lead ores mined in Pembrokeshire, and it is clear that he had put up one or more of these furnaces before the year 1700.[6] Houghton's note, however, refers to existing works, and at this date there seem to have been two at Bristol, and two at Redbrook, on the Wye. One of the Redbrook works belonged to the Governor and Company of Copper Miners of England; whether the furnaces used were of the same form as those of the Bristol lead works, we cannot say. The company had begun in 1691 with furnaces invented by John Duckett and Gabriel Wayne, and they had acquired the patent granted in 1686 to Sir Talbot Clarke and others for an invention from which, according to a statement made in 1715, "great advantage had accrued to the nation."

Swedenborg states "that copper smelting is carried on at many places in England" and mentions two works at Bristol and one at Redbrook.[7] He gives some account of the process and the furnaces as they were thirty years or more before, but it is not possible to fix the date he has in mind within ten years or so, for although for the most part his book seems to have been written about the years 1722–1724, it was not printed until 1734, so that his account may apply to any date between, say, 1692 and 1704. From what he says it is clear that the use of the reverberatory furnace was not confined to calcining; it was used for melting also.

There are some illustrations of the furnaces in Swedenborg's book, but they are merely plans which do not help us very much, and the earliest drawing of any value of a coal-burning reverberatory furnace is that given in the book by the German metallurgist Schlüter, published in 1738.[8] Schlüter had not himself seen the furnaces, but had received the particulars from a trustworthy source in the year 1711. Chapter XIII. of his book, headed "Von Wind-Oefen worin Bley und Kupfer-Ertze geschmoltzen werden," begins with a section entitled "Von einem Wind-ofen in Engelland, Cupolo gennant." A good part of what Schlüter says has been given by Percy ("Lead," page 217). The furnace was to be seen in Flintshire, employed in smelting lead with pit coal, and at Bristol, for smelting copper. It had been invented about the year 1698 by a man named Wright, a doctor of medicine and chemist, and two others, after the expenditure of much time and money. This Dr. Wright, probably, was the Dr. Edward Wright who died at Bath in 1728, and is referred to as "Treasurer of The Company for melting down lead with pit and sea coal, of which Company he was also one of the managers."

The furnace shown by Schlüter—see next page—consists of a hearth and a fire-place separated by a bridge and enclosed in a rectangular mass of masonry and brickwork. Below the fire-place is a large ashpit and at the opposite end of the furnace is the slag hole. In the roof are two openings, one at the middle for feeding the ore, the other, at the end remote from the fire-place, communicates by an inclined flue with a chimney standing at the side of the furnace. The fire door, furnace mouth and tapping hole are in one side of the structure.

The furnace is presumably that then in use for smelting lead in Flintshire. Naturally, in course of time changes were made, and the Flintshire furnace, of, say, 150 years later, as shown by Percy differs in several respects; still,

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* The Newcomen Society for the Study of the History of Engineering and Technology. January 17th.

[1] "De diversis artibus," ed. Robert Hendrie, 1847.

[2] Stahl und Eisen," 1919, p. 1458.

[3] *Ibid.* 1917 (1), p. 184.

[4] Grant Francis, "The Smelting of Copper in the Swansea District," 1881.

[5] Collingwood, "Elizabethan Keswick," 1912.

[6] Mackworth papers, Mr. Glen Taylor's collection.

[7] Swedenborg, "Principia," Vol. 2, 1734.

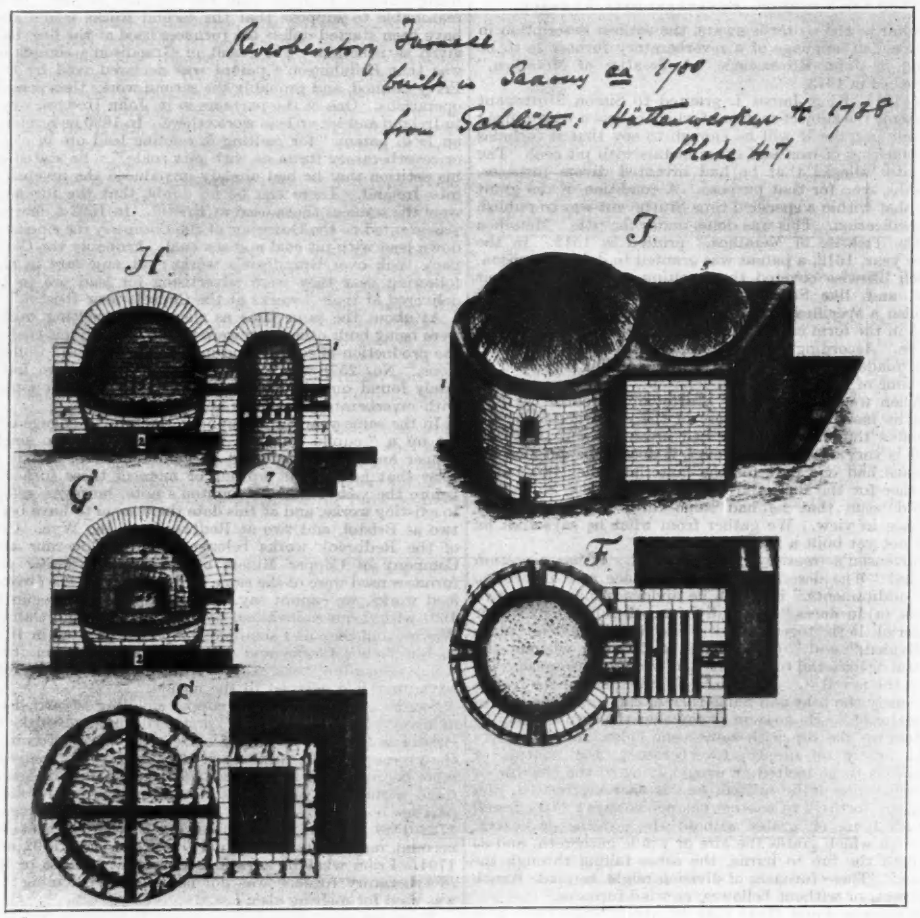
[8] Schlüter, "Gründlicher Unterricht von Huttenwerken, &c., 1738.

the form and proportions are substantially such as might be met with to-day.

We have evidence that there were lead smelting works in successful operation in Flintshire before the end of the seventeenth century. In 1699 (December 21st) we find Robert Lydall writing from Neath to Sir Humphrey Mackworth concerning one of his workmen, Sam Akridge, "who was Mr. Peck's chief man at Flint for 2 years"; Akridge had been sent to Flint on a voyage of discovery.[9] It was from Flintshire that "The Cupolas or low-arched reverberatory furnaces" were introduced into Derbyshire, as John Farey, the elder, tells us.[10]

The Name "Cupola."

We may pause here for a brief consideration of the name applied to these furnaces—*cupola*, *cupelo*, *cupilo*. There is no feature of the reverberatory furnace as we know it to explain the use of this term, but it is possible that in some earlier form, particulars of which have not come down to us, the furnace may have been a round structure with a domed roof and a fire-place at the side. Such a furnace is shown by Schlüter in one of his plates. He had seen it at Schneeberg, in Saxony, but it may be that it was copied from an earlier furnace in England. When Schlüter saw it, the furnace had been idle for some years, and he doubted whether the construction was suitable for the purpose it had been built for, *i.e.*, cupellation. For a furnace of this description the name cupola would not be inappropriate, and one can understand that the name once given might be retained in spite of a change in the form of the roof. But if it is possible to suggest a more or less likely explanation of the use of the name for the reverberatory furnace, it is not so in the case of the foundry cupola. The earliest instance of the use of the term in this sense known to the writer occurs in a description of the Carron Works, printed in 1792,[11] in which "cupola furnaces" are mentioned, and it is quite clear from the context that small blast-furnaces are meant. At about the same date "cupola" appears to have been the name used in the Newcastle-upon-Tyne district, whereas in Derbyshire and Staffordshire they were known as "small blasts" or "hells." However, the consideration of this etymological puzzle is beyond the scope of this paper.



REVERBERATORY FURNACE OF 1700

Chimney Draught.

Of the form and construction of the coal-burning reverberatory furnaces tried before 1711, we have no information, so it is a matter for speculation why the early attempts to smelt lead in them were unsuccessful. It may be that a proper shape of roof had not been arrived at; if the surmise that a domed-shaped top was employed is correct, one can imagine that this might give poor results.

But there is another point which opens out an interesting field for investigation—the draught through the grate. Working without a bellows, how was sufficient air drawn through the fire to secure that activity of combustion that was requisite? When was the action of a chimney in effecting this first observed and when made use of in practice? Chimneys for domestic fireplaces were in use, but they were used merely as vents for the smoke, and probably with the wide-open fireplaces of the time they had little effect in promoting combustion. It was, of course, recognised that there was an upward current of heated air and gas in the chimney, and, in fact, that current was utilised to work smoke-jacks. The question is, when was it recognised that, with a closed fireplace, the air required for the combustion of the fuel could be drawn through by a chimney?

It has been said that furnace chimneys were to be seen at the beginning of the Christian era, and that they are mentioned by the Greek writer, Strabo, in his "Geographica," a work supposed to have been finished about the year 25 A.D., who describes mining and smelting in Spain, and what he says on this point, as rendered in a recent translation, is: "They build their silver-smelting furnaces with high chimneys, so that the gas from the ore may be carried high into the air; for it is heavy and deadly."[12]

Now, the Greek word here translated as chimney means a kiln, oven, or flue. It does not seem possible that it can indicate what we now mean by a furnace chimney. Possibly, what was in view was a funnel long enough to carry the fumes to a height clear of the men working at the furnace, such as we find referred to in 1640 by Barba, who writes of funnels about a yard high as being in use in some places for that purpose.

Reference has been made above to the Keswick works of the Miners Royal Company. The accounts for that undertaking for the year 1569 have been published, translated from the German, and one of the entries reads: "John Fisher heightening the chimney to carry the smoke more completely out of the Smelt-house." It is clear from this that the furnaces vented within the house, and were not themselves provided with chimneys. Possibly, even the provision of a chimney to the house may have been a recent innovation. A drawing of a smelting-house in Lorraine, perhaps thirty years earlier in date, shows the smoke and flame issuing through large openings in the roof.

Coming to our coal-burning furnaces, we have seen that Rovenson, in 1613, describes his furnaces as "close at the top with some vent holes." There is nothing about a chimney, but he does say that he may use bellows.

After Rovenson, we find nothing until we come to Swedenborg and Schlüter, by which time it is clear that the use of chimney-draught was fully established. Swedenborg, writing of copper furnaces, probably about 1720, states that "the smoke stack which leads out of the furnace is in some places made perpendicular, and in other oblique, to take its weight off the furnace." He refers also to the use of these furnaces for roasting calamine, the fuel being brushwood, and here he says "there is a sort of suction of the flame by a flue or chimney at the side of the furnace." Schlüter, as we have seen, has the chimney in his drawing.

It is in this interval between Rovenson and the end of the seventeenth century that we find the first record of the use of chimney draught. It occurs in connection with laboratory furnaces. In 1646, the German chemist, J. R. Glauber, published his book "Furni novi Philosophici," which, in 1651, appeared in English with the title, "A Description of New Philosophical Furnaces." His furnace is a tall, rectangular cabinet, consisting of three compartments, one above the other, and each provided with a door. The bottom compartment is the ashpit, and, in addition to the doorway, it has an opening fitted with a sliding plate to control the entry of air. The compartment above this holds the fire on which a crucible may be placed directly. In the top compartment is a round hole, which, we are told, is "appointed for the flame and smoak; to which if you will use a very violent fire, put to it a strong iron pipe of the height of 5, 6, 8, or 12 feet; for by how much the higher you set your pipe, the stronger fire you may give."

There can be no question that we have here a furnace with chimney draught. Glauber was much pleased with his discovery; it enabled him to carry on his experiments without the aid of a bellows (which required an assistant to work it), and when he opened the door to take out the crucible the flame did not rush out over his hands.

We had Glauber's book in English in 1651, and it is quite possible that, then or later, it may have come into the hands of a man concerned in lead or copper smelting, and that he may have taken the idea from it. However, it is by no means certain that the reverberatory was the first type of industrial furnace to which chimney draught was applied. In the seventeenth century pit coal was being used for a variety of purposes, as for heating liquids, and one can imagine a dyer, himself inconvenienced by the smoke from the fire under his kettle, hanging about under the roof of his shed, deciding to lengthen the funnel to carry the smoke above the roof, and then finding that his fire burned more briskly. However this may be, by the beginning of the eighteenth century, the action of a chimney in promoting draught was widely known. It will be remembered that Savery, in "The Miners' Friend," has drawings in which the boiler furnaces have brick chimneys. In the case of the apparatus placed in a mine shaft, the chimney is a very long one, extending to the surface level, and Savery refers to its effect in promoting ventilation.

Conclusion.

Whether or not the chimney was the critical feature, when once a satisfactory construction had been arrived at, the reverberatory furnace came into use fairly rapidly. We have seen that it was first used for lead and copper smelting; in 1702, or within a year or so, it was in use for smelting tin. By 1700 it had come into use for re-melting pig iron, and from that date we begin to find ironfoundries, as distinct from iron-smelting works, springing up in various parts of the country. One imagines that it was this form of furnace that Abraham Darby must have had when he started ironfounding in Bristol. There were renewed attempts at iron-smelting, but it was not until the introduction of the puddling process that the reverberatory furnace was taken up in the iron trade.

Note.

Since the paper was written, Mr. Glen Taylor has furnished the writer with additional notes from the Mackworth papers. From these notes it is clear that, at the date 1699–1700, the term "cupola" denoted some particular form of reverberatory furnace. Robert Lydall refers to the furnaces used at Neath as "close" furnaces; they had no cupolas, at any rate, at that time.

[9] Mackworth papers, cited above.

[10] Farey, "General View of the Agriculture and Minerals of Derbyshire," 1811.

[11] Sinclair, "The Statistical Account of Scotland," Vol. 3, p. 334, 1792.

[12] "The Geography of Strabo," translated by H. L. Jones. (Loeb edition.) Vol. 2, p. 43.

L.M.S. APPOINTMENTS.

THE following appointments have been approved by the directors of the L.M.S. Railway:—

Mr. R. F. Harvey, District Locomotive Superintendent, Edge Hill, to be Assistant Divisional Superintendent of Motive Power, Manchester.

Mr. J. S. Elliott, District Locomotive Superintendent, Toton, to be District Locomotive Superintendent, Edge Hill.

Mr. R. T. Clews, District Locomotive Superintendent, Patricroft, to be District Locomotive Superintendent, Toton.

Mr. E. M. Ambler, District Locomotive Superintendent, Bescot, to be District Locomotive Superintendent, Preston.

Mr. W. E. Blakesley, District Locomotive Superintendent, Preston, to be District Locomotive Superintendent, Bescot (including Aston and Monument-lane).

Mr. J. C. Foster, Assistant to Superintendent of Motive Power, Derby, to be Assistant to Divisional Superintendent of Operation (Motive Power), Crewe.

Mr. J. Isherwood, Cartage Assistant, District Goods Manager's Office, Broad-street, to be Cartage Assistant, District Goods Manager's Office, Leeds.

Mr. E. Taylor, Chief Controller, Manchester, to be Assistant Divisional Controller, Manchester.

Mr. F. G. Umpleby, Technical Assistant (Outdoor Machinery), Euston, to be Outdoor Machinery Assistant, Crewe.

Mr. J. Mackenzie, Foreman, Mechanical Engineer's Department, Grangemouth Docks, to be Resident Engineer, Grangemouth Docks.

DURALAX.—Duralax is a new tracing paper made by S. C. and P. Harding, Ltd., of Denmark Hill. It is manufactured from 100 per cent. "linen rag" paper by a new method, in which no heat or artificial drying is employed, and it is air dried. It has a matt surface on both sides and we have found it particularly good for pencil work.

ENGINEERS AND ECONOMICS.—The Engineers' Economic Study Group is composed of mechanical, electrical, civil, and chemical engineers, and others having scientific and technical experience, who meet together to exchange views, collect data, and investigate the paradox of poverty amidst plenty, of over-production on the one side and under-consumption on the other. The Group meets, for the time being, every alternate Tuesday, at 6.30 p.m., at the Guildhouse, Berwick-street, London, S.W.1. The Hon. Secretary is Mr. P. Johnson, M.I. Mech. E., Gunnersbury House, Hounslow, Middlesex, to whom those interested can apply for further information.

MR. T. MORRIS PROSSER.—We have to record the death of Mr. T. Morris Prosser, who was associated with Charles D. Phillips, Ltd., Emlyn and Central Engineering Works, Newport, Mon., for over forty-seven years and was manager there as far back as 1890, later becoming joint managing director when the firm was made a limited company. He was widely known in the machinery trade and was also active in public life in South Wales. For the past five years he had been in partnership with his only son, Mr. R. Morris Prosser, in the firm of R. and T. Morris Prosser, engineers, 1, Stow Park Circle, Newport, Mon. It is the intention of Mr. R. Morris Prosser to carry on this business as in the past.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

A Year's Imports and Exports.

The Board of Trade Returns for the year 1933 disclose some startling declines in the imports of iron and steel materials. The total of all the descriptions coming within the category of "iron and steel and manufactures thereof" amounted to 971,425 tons, compared with 1,593,555 tons in 1932 and 2,844,814 tons in 1931. Exports of iron and steel and manufactures thereof comprised a more numerous list of materials than the import classification, but the total, whilst it is higher than for 1932, is less than in 1931, the figures being 1,922,126 tons for 1933, 1,887,295 tons for 1932, and 1,978,958 tons for 1931. The imports of foundry iron last year reached 37,693 tons, compared with 30,107 tons in the previous year, and 109,863 tons in 1931. Of last year's total 25,359 tons came from India. Imports of basic iron last year were 55,276 tons, of which all but 30 tons came from India. In 1932 the imports were 87,428 tons, of which 64,320 tons was Indian basic. In 1933, 229,316 tons of blooms and billets were imported, compared with 360,380 tons in 1932 and 530,563 tons in 1931. As in previous years, Belgium was the largest supplier, the imports from that country totalling 109,752 tons, against 171,863 tons in 1932 and 168,815 tons in 1931. France sent 76,821 tons last year. In December the total imports of semis amounted to 16,017 tons. A notable decrease took place in the imports of sheet bars and tin-plate bars, the total for 1933 being 84,503 tons, compared with 378,871 tons in 1932 and 719,597 tons in 1931. An increase occurred in the year's imports of steel girders, beams and joists, the total being 77,551 tons, compared with 69,739 tons in 1932 and 115,818 tons in 1931. There was a heavy decrease in the imports of plates and sheets, which dropped to 36,980 tons, compared with 75,880 tons in 1932, and 150,408 tons in 1931. On the export side the tonnage of pig iron sent abroad was 107,986 tons, compared with 121,010 tons in 1932. A considerable increase took place in the exports of the more general descriptions of steel, which totalled 114,694 tons in 1933, compared with 97,806 tons in 1932. An improvement also took place in the tonnage exported in a number of steel descriptions; but there was a slight decline in the figures relating to galvanised sheets and tin-plates, and thick plates and sheets. Increases occurred in the exports of plates under ¼in. thick, in tubes, pipes, and fittings, both cast and wrought, and in steel rails.

Iron and Steel Production.

The figures of iron and steel production issued by the National Federation of Iron and Steel Manufacturers continue to show satisfactory progress. There were eighty-one furnaces in blast at the end of December, a net increase of two since the beginning of the month. Two furnaces were closed down for repairs at the Skinningrove Iron Company, whilst two fresh furnaces were blown in at the Stanton Iron and Steel Company's works in the Midlands, one at the Appleby Works in Lincolnshire, and one by the Consett Iron Company, Ltd., on the North-East Coast. The production of pig iron in December amounted to 409,300 tons, compared with 374,900 tons in November, and 284,500 tons in December, 1932. The production includes 101,800 tons of hematite, 203,600 tons of basic, 90,000 tons of foundry, and 6700 tons of forge pig iron. Owing to the Christmas holidays the output of steel ingots and castings in December fell slightly to 668,900 tons from 695,000 tons in November; the output in December, 1932, amounted to 430,400 tons. The December figures bring the total pig iron output for the year to 4,123,600 tons, compared with 3,574,000 tons in 1932, and of steel to 7,002,800 tons, compared with 5,261,400 tons in 1932. The following table shows the average monthly production of pig iron and steel ingots and castings in 1913, 1920, 1931 to 1933, and the production in each month of 1933:—

	Pig iron, tons.	Steel ingots and castings, tons.
1913—Monthly average	855,000	638,600
1920— " "	669,500	755,600
1931— " "	314,400	433,500
1932— " "	297,800	438,500
1933— " "	343,600	583,600
1933—January	286,600	444,400
February	270,800	482,700
March	332,200	577,700
April	324,700	509,600
May	339,900	599,600
June	345,600	568,800
July	343,900	567,500
August	362,700	551,300
September	359,700	669,000
October	373,300	668,300
November	374,900	695,000
December	409,300	668,900

Continental Price Advances.

For some time past there have been reports that the Continental steel manufacturers intended to increase their prices. It was generally assumed, however, that any increase would apply to their export quotations, and not to the prices quoted for the British market. Meetings of the Cartel were held at the end of last week, and it was afterwards announced that prices for Great Britain would be advanced by 2s. 6d. gold. Roughly speaking, this amounted to an advance in sterling of about 5s. For instance, the quotation for merchant bars is now £2 17s. 6d. gold, f.o.b., or £4 6s. 3d. paper, the quotation delivered Birmingham being £6 15s. 9d. Joists B.S. are now £3 1s. 6d. gold, f.o.b., or £4 12s. 3d. paper, which works out at £7 2s. 6d. paper, delivered Midlands, where they have to sell in competition with British joists at £8 15s., less 22s. rebate. At these figures, it does not seem likely that much business in joists will go to the Continent. The quotations for plates for the British market have been left unchanged, but for export, plates, ¼in., ⅜in., and ½in., the price was also advanced 1s. 6d. gold, which makes the f.o.b. quotation for ¼in. £4 gold and £6 paper; for ⅜in., £4 2s. 6d. gold, and £6 3s. 9d. paper, and for ½in., £4 7s. 6d. gold, and £6 11s. 3d. paper.

The Pig Iron Market.

Business in this market is as active now as it was during the early part of December, and some good-sized contracts are being negotiated. The pressure upon the Cleveland makers has become intensified, as the Scottish foundries seem anxious to secure larger supplies. On the other hand, the Cleveland makers have had to refuse business for near delivery. Little export business has been transacted, which is not surprising considering the stringency in the home position, but the makers are doing their best to keep in touch with old overseas customers. Comment has been aroused by the announcement that the ascertained average price for No. 3 Cleveland pig iron for the quarter ended December 31st was 52s. 4½d. per ton, compared with 51s. 7d. for the previous quarter. As the price for a year has been 62s. 6d. for No. 3 Cleveland d/d consumers' works, and 2s. extra to consumers in the north-eastern area, it has puzzled the market to account for the difference, as prices much below the official quotation must have been accepted to make this average. It is suggested that the makers have some low-priced contracts on their books, but these cannot amount to much at the present moment. Another suggestion is that works associated with the producers obtain their iron at much less than the official quotation, but this is denied, and if it were true would probably be strongly resented by independent consumers. It is possible, of course, that arrangements made in the purchase or amalgamation of works are still binding on some of the producers, and this might affect the price. A furnace was started up at Skinningrove last week upon foundry iron, and this should help somewhat to relieve the position. The Midland producers of pig iron are steadily improving their position, and a favourable feature of the market is the growing demand from the heavy engineering foundries. Business, however, is particularly active with the light foundries. A good volume of business has passed in the hematite market, and prices are becoming firmer; in fact, it is not easy to buy at the current price of 62s. 6d. for mixed numbers and 63s. for No. 1. The pig iron requirements of the steel works have also been reflected in an increased demand for basic iron, orders for considerable quantities having been placed recently.

The North-East Coast and Yorkshire.

Active conditions prevail at the steel works on the North-East Coast, and recent orders for ships are now being reflected in an increased demand for shipbuilding steel from the local works. The constructional engineering shops in this district are also better employed than for a long time past, and there are expectations that fresh orders will be obtained shortly, which will further improve the situation. The works producing railway material are busy on the production of steel rails. Prices for general steel materials have shown a tendency to increase, and rounds under 3in. have risen about 5s. to £7 10s. d/d, the export quotation being £6 15s. f.o.b. Similarly, small flats under 5in. have been advanced to £7 5s. d/d and £6 10s. f.o.b. The market seems to regard the possibility of an advance in controlled materials after the next meeting of the steel makers as likely, but, as we pointed out last week, considerations of policy may operate against such a decision. The Yorkshire steel works are, generally speaking, as busy as those in any other part of the country, and some of the most important works are operating at full capacity. It was expected that the price for high-speed steel would be increased this month as the demand for some time past has been on a higher scale than for many years; but the Association has decided to leave the quotations unchanged. It is understood that a fairly large stock of this material exists in makers' hands, and that until these are cleared, consumers will have the benefit of buying at the current rates. The position at the strip mills continues to be satisfactory, and although the demand has been heavy for some months past, it shows no signs of relaxing, in spite of the comparatively low prices quoted by the Continental works. Business in stainless steel also has been well maintained.

Scotland and the North.

Practically all the Scottish works restarted operations at the same rate as before the holidays, and there was, in addition to the work in hand, a good accumulation of orders from the holiday period. The works producing shipbuilding steel already have enough business in hand to keep them occupied for some time, and with fresh orders for ships in sight, there is a good prospect of their being well employed for some months. A contract which has aroused interest is that secured by Colvilles, Ltd., for their Dalziel Works at Motherwell, for 7000 tons of structural steel for use in the rebuilding of the Bank of England. The structural engineering shops in Scotland are irregularly employed, and the demand for steel joists and sections is spasmodic. Business in sheets also has not come up to the expectations entertained a short time ago. Nevertheless, there is a steady demand for the thicker gauges. Export trade in the lighter descriptions, remains disappointing, particularly in galvanised sheets. It is an indication of an improving market, however, that the prices of ⅛in. black sheets, which are not subject to price control, have become firmer, most makers quoting £8 7s. 6d. to £8 10s. for the home market and £8 5s. f.o.b. Glasgow. There has been little change in the conditions ruling in the Lancashire market this week. The structural engineers seem to be improving their position, and as a result there has been a better flow of specifications to the steel works. The active demand for small steel bars continues to be a feature of the market, and although it is only recently that prices were advanced to £7 10s. there is difficulty in placing orders at this figure for forward delivery unless the contract is an attractive one. Premiums of 7s. 6d. to 10s. are heard of, but most works would accept less than this. One or two orders for alloy steel have been received from Russia of late, and others are in prospect. Steady conditions rule in the Barrow and Workington districts. The works can see a good spell of uninterrupted employment before them, and are turning out a substantial tonnage of rails, hoops, and small sections.

The Midlands and South Wales.

Conditions in the Midlands continue to improve, although most branches of the steel industry experience occasional periods when the demand slows down. Business in small bars is a case in point. Until recently the pressure upon the works producing this class of material was persistant, but with the advance in price there has come a slackening in the demand which the makers are inclined to attribute to a greater interest in Continental steel by consumers and merchants. This is hardly surprising as the Continental works kept their quotations at about £1 below the British price for a long period until the end of last week. The drift from British to Continental material has not been serious, but there are a number of running contracts with merchants which will expire shortly and the British makers are wondering if these will be renewed. The increase of 5s. per ton in the delivered price may do something to check the increasing sales of foreign steel. Business in strip seems scarcely affected by Continental competition, although imported material can be obtained at £7 10s. to £7 15s. against British prices of £8 5s. to £9 10s. The structural steel market has improved since the holidays, but the call is chiefly for the smaller sizes. Business in joists, although fairly good, does not increase, and this is somewhat surprising, since all the consumers of note in the Midlands are in the British steelmakers' rebate scheme. Many consumers, however, are still specifying against contracts entered into with the British works some time ago. Since Christmas business in colliery steel has increased, and several contracts have been placed for supplies until the end of June. Prices for this class of steel are expected to be advanced within the next month or two, the current quotations being £7 10s. for bridge rails and £7 12s. 6d. for flat-bottomed rails, and £7 15s. to £8 15s. for arches. In South Wales the tin-plate works, upon which the prosperity of the steel trade in this district largely rests, are well employed, but the demand fails to improve. Strong foreign competition is being met with in the export markets and prices are weak, the quotation having dropped to 16s. to 16s. 3d. for 20 by 14 basis.

Copper and Tin.

The copper market was stirred from the lethargy which has affected it for some weeks by the sentimental influences arising from President Roosevelt's proposal to devalue the dollar. Over the week-end prices were easy, and neither on the Continent nor in the United States did consumers show any inclination to replenish their stocks. The prospect of inflation, however, brought about a change, and in mid-week there was some active buying. On the weaker sterling exchange electrolytic copper advanced to £35 7s. 6d. to £35 10s., the American price being 8·15c. c.i.f. On the Continent a fair amount of buying was reported at £35 10s.; but British consumers maintained a more conservative policy. In America the domestic price remained steady at 8c. d/d, but users showed more interest in the market than for some time past.... The tin market also benefited to some extent by the expectations of inflation in the United States. There was a revival of buying from America, although the quantities disposed of were not so large as might have been expected. Prices, however, advanced, but the upward movement did not last long. There has been rather more speculation in this market of late, and it looks as though some of those speculators who deserted tin for other commodities which offered better prospects of a quick gain are now returning to the tin market. Continental buyers have shown only a moderate interest, but at this season of the year buying from this quarter is usually on the quiet side.

Lead and Spelter.

The easier tendency in the lead market of late may be partly attributed to the slackening in the demand from consumers. This is a seasonal occurrence, resulting largely from stocktaking operations amongst the manufacturers of lead products. Probably towards the end of the month there will be a revival in buying. It is interesting to note that as prices fall the market seems to gain confidence, this feeling being based probably on the belief that values cannot remain at their present low levels for long. Of course, the bad position shown by the December statistics has had much to do with the recent fall in prices; but fears that outputs may be increased as a result of the higher price of silver, which may lead to the increased mining of lead ores containing silver, have also helped to depress the market.... The spelter market has been fairly steady, and although a slightly weaker tendency was noticeable at the beginning of this week, the market does not seem to anticipate any pronounced fall in values. Consumers have shown little interest in the metal, but reports from the Continent indicate that the industrial demand is again becoming stronger. Statistically the position is not bad, since production and consumption appear to be nicely balanced, and it is urged that the present low price of the metal should stimulate its use.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Hematite Mixed Nos.	3 2 6	3 0 0
No. 1	3 3 0	3 0 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	3 5 0	—
MIDLANDS—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 6	—
Basic	3 10 0	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	3 6 0	—
N.W. COAST—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

(*Basic iron prices subject to a rebate of 5/–.*)

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
LANCS.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
MIDLANDS—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. COAST—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
LONDON AND THE SOUTH—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	7 10 0	—
Plates, ¼in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 7 6	8 5 0
NORTH-EAST COAST—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 7 6	7 0 0
Plates, ¼in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 2 6	8 5 0
Boiler Plates, ¼in.	8 5 0	7 12 6
MIDLANDS, AND LEEDS AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 10 0	7 0 0
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 2 6	8 5 0
Boiler Plates, ¼in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
GLASGOW AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 15 0	7 0 0
Plates, ¼in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
SOUTH WALES AREA—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 10 0	7 0 0
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 7 6	8 5 0

IRELAND—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 10 0	8 0 0
Plates, ¼in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	8 15 0	8 15 0
14-G. to 20-G., d/d	10 0 0	9 0 0
21-G. to 24-G., d/d	10 5 0	9 5 0
25-G. to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/3 to 16/6.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic, Soft (25·41% C.)	6 0 0
„ Medium (0·42% to 0·60% C.)	6 17 6
„ Hard (0·61% to 0·85% C.)	7 7 6
„ „ (0·86% to 0·99% C.)	8 7 6
„ „ (1% C. and up)	8 17 6
Soft (up to 25% C.), 500 tons and up	5 5 0
100 tons	5 12 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/9 per lb.	
Ferro Tungsten	2/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 12 6	7/–
„ „ 8 p.c. to 10 p.c.	£21 12 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 10 0	9/–
„ „ „ 1 p.c. carbon	£35 12 6	10/–
„ „ „ 0·70 p.c. carbon	£37 10 0	12/6
„ „ „ carbon free	10½d. per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 0 0 to 17 10 0 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/– per lb.	

NON-FERROUS METAL.

Official Prices, January 17th.

COPPER—		
Cash	£32 3 9 to £32 5 0	
Three months	£32 6 3 to £32 7 6	
Electrolytic	£39 5 0 to £39 12 6	
Best Selected Ingots, d/d Birmingham	£36 0 0	
Sheets, Hot Rolled	£62 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10d.	10d.
„ Brazed (basis)	10d.	10d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
„ Brazed	11d.	11d.
TIN—		
Cash	£227 10 0 to £227 12 6	
Three months	£227 12 6 to £227 15 0	
LEAD:	£11 8 9 to £11 12 6	
SPELTER:	£14 15 0 to £15 0 0	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

LANARKSHIRE—		Export.
(f.o.b. Grangemouth)—Navigation Unscreened		13/3 to 13/6
„ Glasgow— Ell		14/– to 16/–
„ „ Splint		17/–
AYRSHIRE—		
(f.o.b. Ports)—Steam		13/6
FIFESHIRE—		
(f.o.b. Methil or Burntisland)—Steam		14/6 to 14/9
Unscreened Navigation		12/6 to 13/–
LOTHIANS—		
(f.o.b. Leith)—Hartley Prime		14/– to 14/6
Secondary Steam		13/6 to 13/9

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	17/6 to 20/6
Furnace Coke	13/– to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	14/6 to 15/–
„ Second	13/– to 13/3
„ Best Small	10/6 to 11/–
Unscreened	12/– to 13/6
DURHAM—	
Best Gas	14/8
Foundry Coke	17/– to 19/6

SHEFFIELD—	Inland.
Best Hand-picked Branch	27/– to 28/–
South Yorkshire Best	22/– to 24/–
South Yorkshire Seconds	17/6 to 19/6
Rough Slacks	6/– to 9/–
Nutty Slacks	7/– to 8/6
Furnace Coke (at ovens)	12/3

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/–
Foundry Coke	21/– to 36/–
Furnace Coke	18/6 to 20/–
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm	9/6 to 10/6
Steam Coals:	
Large	18/– to 20/–
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ½d. per gallon extra

French Engineering Notes.

(From our own Correspondent in Paris.)

Anglo-French Trade Treaty.

THE principle underlying France's foreign trade policy is to preserve a balance between the industrial and agricultural home productions, and to adjust imports in such a way as to afford adequate protection to both and to secure the maximum of facilities for export. How these results can be achieved in a manner satisfactory to everyone is not quite clear. The farming interests far exceed in importance the manufacturing industries, and the measures of rigid protection which have to be adopted for agriculture react necessarily on other productions that depend entirely on foreign trade. The Government has therefore adopted a policy which it hopes will enable it to control the many factors governing a complex commercial situation, notably in limiting imports to what is necessary to protect the home production without closing foreign markets and to provide for supplies of raw material. The idea that this country could stand alone in industrial and commercial isolation has been abandoned, but the fact that every branch of industry has been more or less developed would appear to limit considerably the possibilities of commercial agreements if it were not for the absolute necessity of many industries recovering their former connections with foreign markets. It may therefore be confidently hoped that the negotiations between France and Great Britain will be pursued on a broader basis than would seem to be indicated by a desire to encourage industries that are solely interested in the home demand. In view of these negotiations the French Government had reserved 75 per cent. of the import quotas for the purpose of allotting them to countries offering reciprocal advantages. By a curious coincidence they were extended to goods that covered practically everything imported from Great Britain. In consequence of the refusal of the British Government to entertain a new treaty unless the full quotas were restored the French Government is preparing to give satisfaction to Great Britain so far as British imports are concerned. The same concession had to be made in the case of the United States.

The Congo-Ocean Railway.

The great enterprise which the French are now completing for putting their possessions in Equatorial Africa into communication with the sea has probably received less attention than it deserves. Until recently these possessions were dependent on the Belgian Congo Railway system, but with the completion in April next of the line between Brazzaville on the Congo and Pointe-Noire on the Atlantic coast the French will have direct transport facilities through their own territory. For some time the two sections being constructed from opposite ends have been utilised by connecting them up with road lorries. The undertaking was rendered particularly difficult by the character of the country through which the railway passes, and by the absence of any suitable site for a terminal port, the short coast line offering no conveniences for the construction of a harbour. Advantage was taken of a spit of land at Pointe-Noire to extend it by a wharf into deep water. Pointe-Noire is already a modern planned town, and the wharf equipment and warehouses are capable of dealing with all the traffic for the time being. Further works are to be put in hand for the construction of wharves and of a sea wall with landing stages. On the completion of the programme there will be more than 5000 m. of wharves, one of them extending 2250 m. from the shore. The railway passed through unusual vicissitudes because of failure to realise that its construction from Brazzaville through jungle, mountains and swamps could not be undertaken with native labour which was quite unsuitable for the work. The construction was suspended until arrangements could be made to resume work from both ends with the aid of labour-saving machinery and plant. The railway is now practically completed, and is noteworthy for the number of bridges and the length of tunnels, some of which were driven through the mountain range under conditions of great difficulty.

Railway Signals.

Confidence in automatic signalling systems has been shaken by the Lagny disaster, which is known to have been caused, partially at least, by defective signal working, although six engineers have been charged with negligence in their supervision. Monsieur Charlot, President of the Superior Railway Council, is of the opinion that no automatic system can provide absolute safety and deprecates attempts to suppress the human factor in railway working. Monsieur Charlot believes that there is no reason why locomotives should not carry lights enabling drivers to see the road a considerable distance ahead, while the tail lights of trains should be made more visible. The Superior Railway Council has long advocated electrification, contrary to the attitude of many experts who do not believe that the transformation of existing lines is economical, but Monsieur Charlot is of the opinion that electrification alone offers absolute safety. Some time ago the Council submitted a plan for the electrification of about 3000 miles of railway. It was turned down by the military authorities, who would not sanction the electrification of railways serving the frontier. The Nord Railway Company has arranged to ensure the greatest possible reliability of the human factor by installing a psycho-technical laboratory under the direction of Monsieur Lahy, professor of psychology at the Sorbonne, where all the men occupying responsible positions, such as engine drivers and signalmen, are tested to ascertain their physical and mental reactions and reflexes while on duty.

Coal.

Negotiations continue to be carried out on behalf of British coalowners whose interests have been jeopardised by the further reduction of import quotas into France. It is expected that they will be allowed an additional 30,000 tons a month in return for purchases of pit props, which were taken as return freights before the coal import quotas reduced the tonnage of British colliers calling at Bordeaux and neighbouring ports. South Wales coalowners found it an advantage to get their pitwood elsewhere.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

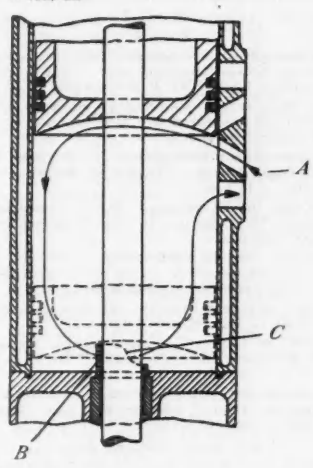
The date first given is the date of application; the second date at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

402,702. July 10th, 1933.—PROTECTING PISTON-RODS AGAINST HEAT, Maschinenfabrik Augsburg-Nurnberg Aktiengesellschaft, 7, Stadtbachstrasse, Augsburg, Germany.

When a double-acting, two-stroke engine is supplied with scavenging air on one side of the cylinder only, as shown at

Nº402,702



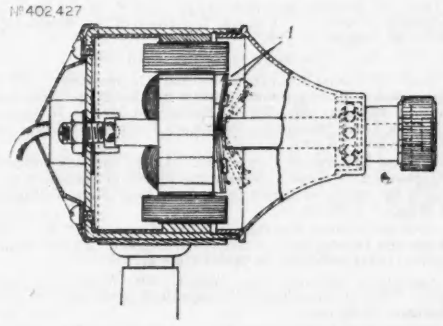
A, there is a liability for the piston-rod to become warped on account of the difference in temperature of its two sides. A protective sleeve is consequently provided at B, and is cut away, as shown at C, so that the heating effect of the combustible charge is proportioned to the cooling effect of the scavenging air.—*December 7th*, 1933.

DYNAMOS AND MOTORS.

402,427. June 1st, 1932.—PERMANENT-MAGNET DYNAMOS, Frederick John Miller, of 9, Stonehouse-road, Sutton Coldfield, and William Robert Smith, of 13, Chudleigh-road, Erdington, Birmingham.

A scheme is described in this specification for controlling the voltage of a variable-speed permanent-magnet dynamo.

Nº402,427

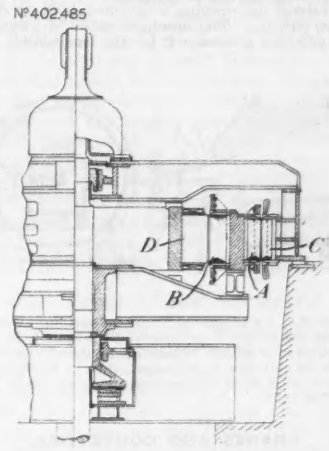


The flux density across the air gap between the rotor and stator is varied inversely as the speed of the rotor by means of a centrifugally controlled armature A, which approaches the poles as the speed rises, and so forms a magnetic shunt. By varying the strength of springs the displacement of the flaps forming the shunt can be regulated so that the flux control can begin at any desired speed.—*December 1st*, 1933.

402,485. June 10th, 1932.—DYNAMO-ELECTRIC MACHINES, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2, and Frederick Horton Clough, of Kilsby, in the County of Northampton.

The driving heads of prime movers, such as water wheels or turbines, driving A.C. generators, are subject to variation between wide limits, resulting in variation in the speeds at which the turbines will run efficiently. To overcome the trouble a combination of two alternating-current dynamo-electric machines are employed. The field member A of the main machine and the armature B of an auxiliary machine are both mounted on the rotor. The main field member A is constructed similarly to a slip-ring rotor for an induction motor, i.e., with phase winding and laminated core. The main armature C, which is stationary, has a normal alternator stator winding. The windings of the main field member A and of the auxiliary armature B are polyphase windings having any convenient number of phases. The auxiliary armature B works in a field produced by the poles D of the stationary auxiliary field member. When the generator is run at normal speed, the field member A is excited with direct current through slip rings from an external source, while the auxiliary machine is idle. When the generator is to be run at low speed, the connections to the direct current source are removed, and the field member A is directly connected to the auxiliary armature B, which revolves with it. The poles D of the auxiliary machine are excited with direct current, and thus a polyphase alternating current of low frequency is generated in auxiliary armature B and is passed through the main field winding A, the poles D being few in number. A field is produced rotating slowly relatively to the field member A, and the connections must be such that this rotation is in the same sense as the actual rotation of the field member. At a definite low speed of the field member, normal speed of the field is obtained, and normal frequency currents are generated in the main stator winding C. When the generator is to be run at high speed, the connections between the auxiliary armature B and the main field member A are reversed. The field then rotates backward relatively to the field member, and normal speed of field rotation is obtained with an actual speed

Nº402,485

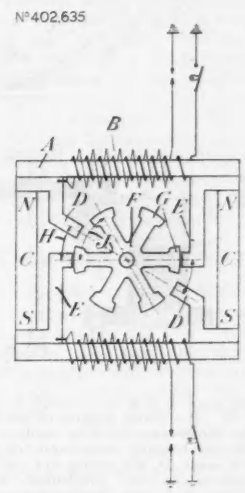


of the field member above normal. Thus, three distinct alternator speeds are obtained, each giving stator output at normal frequency.—*December 7th*, 1933.

402,635. March 8th, 1933.—MAGNETO-ELECTRIC IGNITION MACHINES, Robert Bosch Aktiengesellschaft, of 4, Militärstrasse, Stuttgart, Germany.

The magneto described in this specification has stationary magnets and a stationary winding with a rotary magnetic inductor, and is of the type in which the like poles of the stationary magnets are connected by magnetic members carrying armature coils. An armature core A, on which an ignition coil B is mounted, is arranged between each of the north poles N, and a second wound core is arranged between the south poles S

Nº402,635



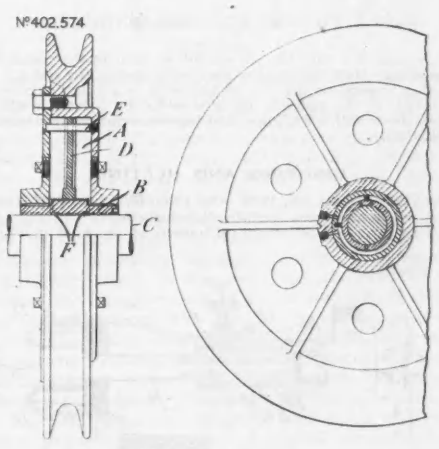
of the two permanent magnets C. Pole-shoes D, E are symmetrically disposed between the ends of the magnets and armature cores, and extend into the space enclosed by the magnets. The armature cores and their ends lie on a circle, a pole-shoe on the north pole of the one magnet being situated diametrically opposite a pole-shoe on the south pole of the other magnet. The star-shaped rotary magnetic inductor F has six arms, which are provided at their ends with pole-shoes G. The pitch H of the two pole-shoes of each of the magnets is half as great as the pole-pitch J of the rotary magnetic inductor.—*December 7th*, 1933.

TRANSMISSION OF POWER.

402,574. September 26th, 1932.—THE LUBRICATION OF BEARINGS, R. T. James, P. C. G. Hausser, and R. L. Aitken, Bush House, Strand, London, W.C.2.

This crane pulley is made hollow, with a grease receptacle A, and is mounted on a loose bush B, on the shaft C. Inside the grease box there is a disc D, screwed on to the bush B. The disc

Nº402,574

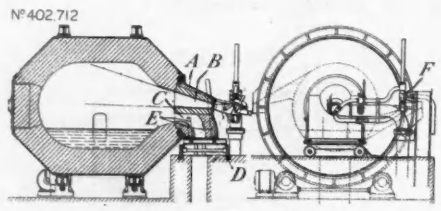


is prevented from rotating with respect to the pulley by the pin E. Should the bush seize on to the fixed shaft and the pulley continue to rotate, the disc will move along the screw and force grease through either of the passages F F to lubricate the bush. A modification for application to thrust bearings is also mentioned.—*December 7th*, 1933.

FURNACES.

402,712. March 20th, 1933.—ROTARY AND SEMI-ROTARY FURNACES, W. F. Wiltshire, 16, Birmingham Factory Centre, Kings Norton, Birmingham.

In this furnace one opening is provided, both for firing and for charging purposes. This opening is closed by a burner block A, which provides a passage B for the combustible mixture,

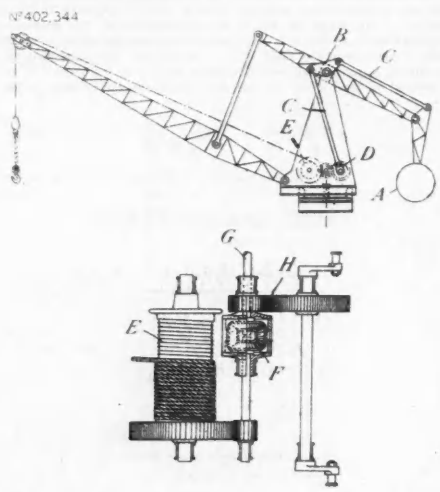


and an outlet C, for the products of combustion. This block is mounted on the trolley D by means of the links E E, so that it can be retracted from the furnace opening and drawn aside to permit the introduction of a charge. The fuel and air services are swivelled at F, so as to permit the retraction of the block.—*December 7th*, 1933.

CRANES AND CONVEYORS.

402,344. May 12th, 1933.—SELF-STABILISING JIB CRANES, W. H. Watkins, 95, Elthorne-avenue, Hanwell, London, W.7.

The load lifted by this crane is balanced by the weight A, and the object aimed at is to effect a balance proportional to the actual load. The weight, it will be seen, is hung on a system of links connected with the jib, and can be swung in or out to determine its effectiveness by the lever B, rods C C, and crank

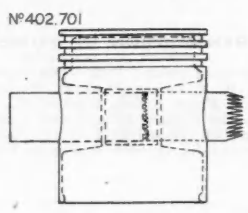


D. The hoisting winch E is driven through a differential gear F by the shaft G. The planet pinions of the gear drive the crank D through the gearing H. The result is that no drive is transmitted to the hoisting drum until the planet pinions have rotated the crank D, and swung out the counterweight sufficiently to balance the load. Incidentally, should the load be excessive, the crank D will pass the top dead centre and prevent the overloading of the crane.—*November 30th*, 1933.

MACHINE TOOLS AND SHOP APPLIANCES.

402,701. July 10th, 1933.—A DEVICE FOR INSERTING THE PISTON PIN IN THE PISTON AND PISTON-ROD, K. Bley, No. 37, Harsdorforstrasse, Magdeburg, Germany.

The invention is described as above in the specification, but in this country it would be more generally described as a device for putting the gudgeon pin into the piston and connecting-rod.

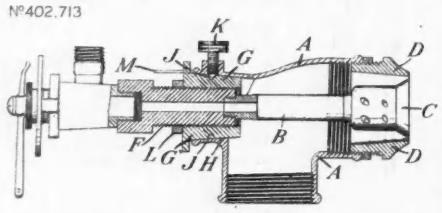


It is suggested that the pin should be fixed in the piston by shrinking—that is to say, by previously heating the piston. It is then imperative that the parts should be got into alignment quickly, so the gudgeon pin is preceded by a light, resilient steel sleeve with a leading end of tapered serrations.—*December 7th*, 1933.

LIGHTING AND HEATING.

402,713. August 8th, 1933.—OIL FUEL BURNERS, J. H. Dine, 60, Mount-street, Nechells, Birmingham.

This invention relates to oil burners of the kind in which



the jet tube is attached to a taper plug removably fitting into a taper socket or body portion in the burner. The object is to provide means whereby the jet tube and jet can be moved bodily within the burner in order to adjust the position of the jet relatively to the nozzle, from the rear of the burner. A is the burner body and B the jet tube with a jet C, and the nozzle is shown at D. The rear portion of the jet tube is screw-threaded externally at F, and engages a correspondingly screw-threaded bore in the taper plug G. The taper plug engages a conical seating H in the burner body, and is formed with a peripheral groove J into which the set screw K engages to lock the plug in place in the burner body. A lock nut L is provided for locking the jet tube and taper plug together, and locate the jet centrally in the nozzle. A pointer, shown at M, may be attached to the rear of the taper plug to show at a glance on a scale the position of adjustment of the jet in the nozzle.—*December 7th*, 1933.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF ELECTRICAL ENGINEERS: N.E. STUDENTS.—Armstrong College, Newcastle-upon-Tyne. "Radio Interference from High-voltage Lines," Mr. J. H. Summer. 7.15 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. "Presentation and Discussion of a Symposium of Papers Dealing with Invention." 6 p.m.

INST. OF STRUCTURAL ENGINEERS.—At Merchant Venturers' Technical College, Bristol. "Design of Welded Structures," Mr C Helsby. 7.15 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Some Modern Developments in Fire Extinguishment," Mr. E. C. Prince. 7.30 p.m.

PHYSICAL SOC.—At Imperial College of Science and Technology, S. Kensington, W.7. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.; meeting, 5 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse by Mr. G. Elliot Smith. 9 p.m.

UNIVERSITY OF LONDON.—King's College, Strand, W.C.2. "Apparatus for Power Factor Correction," Mr. D. B. Hoseason. 5.30 p.m.

WEST OF SCOTLAND IRON AND STEEL INST.—Royal Technical College, Glasgow. Council meeting, 6.45 p.m. Discussion on "Metallurgical Aspects of Welding." 7.15 p.m.

SATURDAY, JANUARY 20TH.

HULL ASSOC. OF ENGINEERS.—Municipal Technical College, Hull. "History of Coal Mining," Mr. Dean Harrison. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Visit to works of John Lumb and Co., Ltd., glass bottle manufacturers, Castleford. 3.15 p.m.

INST. OF MARINE ENGINEERS: JUNIOR SECTION.—Visit to Battersea Power Station. 10 a.m.

MONDAY, JANUARY 22ND.

BRADFORD ENGINEERING SOC.—Bradford Technical College, Bradford. "The Theory and Practice of Case-hardening," Mr. G. M. Flather. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN CENTRE.—Armstrong College, Newcastle-upon-Tyne. "Some Aspects of the Electrical Transmission of Power by Means of Direct Current at Very High Voltages," H. Rissik. 7 p.m.

INST. OF MECHANICAL ENGINEERS: GRADUATES.—Storey's-gate, S.W.1. "New Cutting Alloys," Mr. C. R. Perks. 6.45 p.m.

INST. OF STRUCTURAL ENGINEERS.—At S. Wales Inst. of Engineers, Cardiff. "Cinema Construction in Steelwork," Mr. G. E. Cooper. 7 p.m.

TUESDAY, JANUARY 23RD.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Discussion, "Hammer-blow Impact on the Main Girders of Railway Bridges," Mr. R. W. Foxlee and Mr. E. H. Greet; "Moving Load Stresses in Short-span Railway Bridges," Mr. W. E. Gelson. 6 p.m.

INST. OF ELECTRICAL ENGINEERS.—At 39, Elmbank-crescent, Glasgow, C.2. "Some Aspects of the Electrical Transmission of Power by means of Direct Current at Very High Voltages," H. Rissik. 7.30 p.m.

INST. OF MARINE ENGINEERS.—The Minories, E.C.3. "The Origin and Development of Heavy Oil Engines," Akroyd Stuart Award (1933) Paper, Mr. S. Hicks. 6 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield. "Bright Annealing in Nitrogen-hydrogen Gas," Mr. P. T. Holligan. 7.30 p.m.

STEPHENSON LOCOMOTIVE SOC.: SCOTTISH BRANCH.—Royal Technical College, Glasgow. "Some Railway Travels," illustrated by lantern. Mr. John McInnes. 7.45 p.m.

WEDNESDAY, JANUARY 24TH.

INST. OF CIVIL ENGINEERS: STUDENTS.—Great George-street, S.W.1. "Some Drainage Works at Hayes," Mr. L. G. Butterworth. 6.30 p.m.

INST. OF FUEL.—St. Ermin's Hotel, S.W.1. Informal meeting, discussion, "Oil as an Ally of the Coal Trade." 7 p.m.

INST. OF PRODUCTION ENGINEERS: BIRMINGHAM GRADUATES.—At James Watt Memorial Inst., Birmingham. "Welding Procedure," Mr. G. G. Musted. 7 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C. "Modern International Practice in Factory Design," Mr. Hal Williams. 8 p.m.

THURSDAY, JANUARY 25TH.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—At James Watt Memorial Inst., Birmingham. "Experiments and Measurements in Connection with the Purification of Sewage," Mr. F. C. Vokes. 6 p.m.

INST. OF CIVIL ENGINEERS: YORKSHIRE ASSOC.—Great Northern Hotel, Leeds. Annual dinner. Reception, 6.30 p.m.; dinner, 7 p.m.

INST. OF ELECTRICAL ENGINEERS.—Meeting cancelled.

INST. OF LOCOMOTIVE ENGINEERS.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Boiler Repairs," Mr. R. I. Kirkland. 6 p.m.

INST. OF MINING AND METALLURGY.—At the Rooms of the Geological Society, Burlington House, Piccadilly, London, W.1. "Silicosis," Mr. W. R. Jones. 5.30 p.m.

INST. OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W.1. "The Actual Strength of Steel I-beams," Mr. Ewart S. Andrews. 6.30 p.m.

FRIDAY, JANUARY 26TH.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. "Automatic Combustion Control of Boiler Plants." Messrs. J. L. Hodsgon and L. L. Robinson. 6 p.m.

INST. OF STRUCTURAL ENGINEERS.—At James Watt Memorial Inst., Birmingham. "Reinforced Concrete Bins and Silos," Mr. A. E. Jennens. 6.30 p.m.

INST. OF STRUCTURAL ENGINEERS: LANCASHIRE AND CHESHIRE BRANCH.—Midland Hotel, Manchester. Annual Dinner.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Air for Combustion with special reference to Air Heaters," Mr. A. E. Bingham. 7.30 p.m.

N.E. COAST INST. OF ENGINEERS AND SHIPBUILDERS.—Mining Inst., Newcastle-upon-Tyne. "The Possibilities of Applying Improvements Effected in Land Power Plant to Ship Propelling Machinery," Messrs. W. T. Bottomley, E. W. Corlett, and F. Piercy. 6 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1.—Discourse, "Dust and Smoke," Dr. R. Whytlaw-Gray, F.R.S. 9 p.m.

TEES-SIDE INDUSTRIAL SAFETY COMMITTEE.—Cleveland Technical Inst., Middlesbrough. "Workers and Safety First," Mr. R. Dennison. 7.30 p.m.

UNIVERSITY OF LONDON.—King's College, Strand, W.C.2. "Apparatus for Power Factor Correction," Mr. D. B. Hoseason. 5.30 p.m.

SATURDAY, JANUARY 27TH.

INST. OF ELECTRICAL ENGINEERS: N.E. STUDENTS.—Visit to Rope Works of Messrs. R. Hood Haggie and Son, Willington, Quay-on-Tyne. 2.30 p.m.

MONDAY, JANUARY 29TH.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN CENTRE.—At the Rendez-Vous Restaurant, Pilgrim-street, Newcastle-upon-Tyne. Informal meeting. Discussion, "Load Building." 7 p.m.

TUESDAY, JANUARY 30TH.

INST. OF TRANSPORT.—London, informal meeting. Discussion, "Traffic Light Control Signals," opener, Mr. J. S. Pool.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. "Ternary Systems," Mr. E. Gregory. 7.30 p.m.

WEDNESDAY, JANUARY 31ST.

INST. OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOC.—Midland Hotel, Manchester. Annual dinner. Reception 6.30 p.m., dinner 7 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C. "The Pooling of Water Supplies," Mr. Alan E. L. Chorlton. 8 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

STERNOL LTD., Finsbury-square, London, inform us that, in view of the generally improved outlook in trade, they have decided to increase considerably the area of their works and to install new up-to-date machinery.

IN view of the merger of the two old-established firms, Horseley Bridge and Engineering Company, Ltd., and Thomas Piggott and Co., Ltd., the firm is, since January 1st, operating under the name of Horseley Bridge and Thomas Piggott, Ltd., with administration offices at Tipton, Staffs.

THE MIRRLEES WATSON COMPANY, Ltd., informs us that it has taken over the small steam turbine business previously carried on by Scott and Hodgson, Ltd., Guide Bridge, Manchester. The Mirrlees Watson Company has purchased the complete designs, outline drawings, technical data, patterns, and special tools, and has engaged the services of Mr. R. P. Turney, who has had charge of this section of Scott and Hodgson's business for the past six years. The turbines are of the impulse type, and are manufactured as either radial or axial flow, in sizes from ½ to 400 B.H.P.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

THE ENGLISH ELECTRIC COMPANY, Ltd., has recently received from Edmundson's Electricity Corporation for Ilfracombe an order for oil-engined alternator sets for a normal full-load output of 500 B.H.P. at 375 r.p.m., with a 10 per cent. overload for two hours. It will be direct coupled to a 346-kW English Electric alternator with overhung exciter, generating power at 400/440 volts, three-phase, 50 cycles; and an order from Messrs. Siemens, Australia, for Messrs. Pike Brothers, Gunnedah, for a 3 "K" type airless injection cold-starting four-stroke 600 r.p.m. oil engine, which will be direct coupled to a 125-kVA English Electric alternator generating power at 440/254 volts, three-phase, 50 cycles.

SUBMARINES.—H.M. submarine "Severn" was launched at the Naval Construction Works, Barrow-in-Furness, on Tuesday, January 16th. The naming ceremony was carried out by Mrs. Forbes, the wife of Vice-Admiral C. M. Forbes, C.B., D.S.O., Controller of the Navy. H.M.S. "Ajax" will be launched on Thursday, March 1st, at 11 a.m., at the same shipyard. In this case the naming ceremony will be performed by Lady Chatfield, the wife of Admiral Sir A. Ernle M. Chatfield, K.C.B., K.C.M.G., C.V.O., the First Sea Lord and Chief of Naval Staff.

INSTITUTION OF MECHANICAL ENGINEERS.—The annual dinner of the North-Western Branch of this Institution was held at the Engineers' Club, Manchester, on Thursday, 11th inst. The attendance was quite up to the average, and Professor Dempster Smith, Chairman of the Branch, who presided, received a very hearty welcome on his recovery from a serious illness. The toast of "The Institution of Mechanical Engineers" was proposed by Dr. H. J. W. Hetherington, M.A., Vice-Chancellor of Liverpool University. Dr. Hetherington, in the course of an admirable speech, said that the advent of science and engineering had a greater influence in the world than anything which had happened in history, and engineers could not altogether evade responsibility for the management of the world which in large part they had brought into being. It was for them to see, as far as in them lay, that the fashion in which their professional problems were solved was guided to the end of human happiness rather than to the end of human suffering and destruction. Dr. Hetherington welcomed the forthcoming summer meeting in Liverpool and trusted it would meet with success. The toast was acknowledged by Mr. Alan E. L. Chorlton, President of the Institution, who deplored the division of interests which exists in Lancashire, where the members of the cotton trade were unable to pull together. He advocated that much more energy should be devoted to research and referred to the steps which were being taken in Germany, which he had recently visited, to organise "selective" education. He also referred to his recent trip on the Zeppelin railway train, which is provided with hydraulic transmission. At a speed of 100 miles an hour, Mr. Chorlton said, the motion of the train was delightfully smooth, owing to the provision of rubber balls between the body of the coach and the framework. The toast "Our Guests" was proposed by the President Designate, Mr. Charles Day, M.Sc. Tech., and was responded to by the Lord Mayor of Manchester, Alderman Joseph Binns, and Major P. J. Cowan, M.B.E. The toast of "The Chairman" was proposed by Mr. G. N. Shawcross, M.B.E.

A Seven-Day Journal

British Industries House.

ENCOURAGED by the support promised by buyers, both British and foreign, of the scheme for the establishment of a buying and selling centre for British goods at British Industries House, Oxford-street, London, W.1, the board has decided to proceed at once with the erection of showrooms and show-cases on the chief floors. It is confidently anticipated that within the next few months sufficient firm bookings will have been secured to enable the House to open as a central buying depôt for British goods, both from home and from the Dominions and Colonies. The board has further decided to open the Buyers' Club next month. Through the Buyers' Association of Great Britain, which, with a membership of over 600, has already established its headquarters in the House, that Club, we are informed, is already assured of more than sufficient support to keep it busy, and it is felt that a business club in London in such a central position will be greatly appreciated by overseas buyers, particularly during their visit to the British Industries Fair. During the past three months, and more particularly since the announcement that six of the leading London insurance companies are behind it, and the appointment of the present board, British Industries House has received promises of support from Chambers of Commerce, both at home and overseas, from manufacturers' associations, and other official and semi-official bodies.

The Transport of Liquid Rubber.

ON Thursday last, January 18th, the largest cargo of liquid rubber or latex ever transported by sea was safely discharged from the Blue Funnel Line steamer "Eumæus" into specially designed tanks at the Liverpool Docks, from which it will be re-shipped to the Dunlop Rubber Company's works. This method is in marked contrast with the earlier practice of bringing the latex to England in 45-gallon drums. The fluid was discharged at a rate of 300 gallons per minute. According to the new plan, the latex, which is carried from the Dunlop plantations in British Malay to Singapore, is there concentrated to a 60 per cent. rubber content, compared with the 35 to 38 per cent. concentration which was used with the earlier method of transport. The storage tanks or containers at the Liverpool Docks are worthy of mention, as they are welded structures and form two of the largest vessels of the kind ever moved in one piece by road transport. They are 35ft. in overall length with a breadth of 14ft. and are designed to hold 26,000 gallons of latex. When full, they weigh close upon 120 tons.

An Irish Loop Railway.

ON Wednesday, January 17th, the Duke of Abercorn, the Governor of Northern Ireland, formally declared open the new loop line of the Northern Counties section of the London, Midland and Scottish Railway Company at Greenisland, Co. Antrim. This loop, which has been built at a cost of close upon £250,000, branches off from the Larne line near White Abbey and joins the old main line near Mossley. It will obviate the necessity for trains to and from Belfast and stations north thereof running *viâ* Greenisland and reversing and changing engines at that station, and will effect an acceleration of twenty-five minutes in the Belfast, Portrush and Londonderry services. The line has a length of about 3 miles and a continuous gradient of 1 in 75. It has necessitated the excavation of some 240,000 cubic yards of earth. The maximum depth of cutting is 22ft. and the greatest height of embankment 35ft. The viaduct on the main line has a length of 630ft. and is stated to be the largest reinforced concrete viaduct in the British Isles. There is another viaduct on the Larne line, which has a length of 400ft. Over 32,000 tons of concrete and 700 tons of steel reinforcement were used in the construction of these two viaducts. In addition, it was necessary to build eight bridges, four of which are underbridges. The construction of the new line has occupied more than three years.

The Late Sir Ernest Glover.

BRITISH shipping has lost a great leader by the death of Sir Ernest William Glover, which took place at his home at Hadley Hurst, Barnet, on Sunday last, January 21st. Sir Ernest, who was in his seventieth year, was a partner in the London firm of Glover Brothers, the managing owners of the Shakespear Shipping Company, Ltd., and ship and insurance brokers. He was deeply concerned with the present state of British shipping, and was Vice-chairman of the Tramp Owners' Committee appointed by the Chamber of Shipping, and one of its representatives who recently addressed the Grand Council of the Federation of British Industries on the outlook for British shipping. During the war he was Director of the Ship Management Branch of the Ministry of Shipping, and was a member of the Admiralty Transport Department Advisory Committee in 1915 and 1916. For his war services Sir Ernest was created a Knight in 1918 and a Baronet in 1920, and he also received Belgian and Norwegian decorations. In 1923 he was President of the Chamber of Shipping, while for 1924 to 1928 he was Chairman of the Baltic Mercantile and Shipping Exchange. In a telegram sent to Lady Glover on January 22nd by Mr. W. J. McAlister, the President of the Chamber of Shipping, and signed by Mr. R. J. Dunlop, Vice-president, and Sir F. Vernon Thomson, Chairman of the Documentary Committee, it was stated that the whole shipping industry shared Lady Glover's profound loss and grief. Sir Ernest was, it pointed out, one of the most distinguished leaders of the Chamber of Shipping, and was universally admired for the beauty of his character, his statesmanship, and his unselfish devotion to public service.

Southampton Graving Dock.

ON Friday, January 19th, the world's largest liner, the 56,590 gross ton White Star liner "Majestic" was safely docked in the King George V. graving dock at Southampton. The occasion marked the first commercial use of the dock since it was opened by the King in July last. The docking of the ship was postponed from the preceding day, owing to a strong south-western gale. The ship entered the dock shortly after two o'clock, and immediately afterwards the entrance was closed and the pumping operations were begun. They occupied about four hours. The control of the four 54in. pumps and valves was greatly simplified by the arrangement whereby all controls are grouped on one desk in the motor room. There a system of coloured lights indicates all the valves, and shows which pumps are running. On the preceding day at an official luncheon, at which the principal officials of the Southern Railway Company and the White Star Line attended, Lord Essenden, the chairman of the White Star Line, referred briefly to the merging of the Atlantic interests of the Cunard and the White Star lines, which, he said, would benefit the Port of Southampton.

The Grampian Electricity Scheme.

WITH the completion of the second stage of the Grampian hydro-electric works and the generating station at Tummel Bridge, the Grampian Electricity Supply Company announces that it hopes to make supplies available shortly along the north-eastern coast from Laurencekirk to Stonehaven, Forres, Nairn, and the intermediate villages. The plant installed in the Tummel Bridge station has a designed output of 34,500 kW, and coupled with the output of the generating station at Ericht, which has been supplying electricity for three years, makes a total plant capacity of 66,500 kW. The two generating stations together constitute the largest hydro-electric power scheme in the British Isles designed for the purpose of general supply. A scheme of high-tension transmission has been provisionally planned for conveying current through the most important centres of population in the Scottish Highlands by means of overhead lines, and good progress is being made with the initial stages of this work. The rates of supply in the Scottish Highlands area, which is to a large extent sparsely populated, are claimed to be comparatively low.

New Shipbuilding Orders.

THE Blue Star Line has placed an order with Harland and Wolff, Ltd., for a 13,400-ton motor liner, which is intended to inaugurate a monthly service to and from Australia for carrying chilled beef and refrigerated produce. The new liner, which is similar to the two sister ships now under construction in the firm's East Yard, will have a length of 515ft., with a 70ft. beam, and will be designed for a sea speed of 16 knots. This ship is the third ordered by the Blue Star Line and the tenth order given to British shipyards during the last few months for vessels for the Australian and New Zealand trades. The aggregate tonnage of these vessels is over 112,000 gross tons and represents about one-third of the total tonnage now under construction in British shipyards. The Booth Line has ordered from Cammell Laird and Co., Ltd., of Birkenhead, two 5000-ton cargo steamers, which will be propelled by reciprocating steam engines with Bauer-Wach exhaust steam turbines. During the past few days several smaller orders have been announced.

Fires Aboard Ship.

AN important section of the annual report of the Committee of the Liverpool Underwriters' Association, which is to be submitted at the annual meeting on Monday next, deals with the question of fires aboard ship. The Association's records show that 303 cases of fires on steamers and motor vessels occurred during the year 1933, compared with 314 in the preceding year. Of these 52 took place in bunkers, against 55 in 1932, and 251 in cargoes, against 259 in the year before. The average number of fires was 478 for the period 1923 to 1933. The figures above-mentioned include 19 serious cases, 13 of them foreign, aggregating 74,102 tons, and 6 British, totalling 36,132 tons, 8 of which, all of them foreign, resulted in total losses. Inquiry into the problem of ships' fires still continues, and last year numerous safeguarding devices were inspected by the Committee. The main question of endeavouring to ascertain the chief causes of fires is being considered by three technical committees which will report to the General Committee, and so enable a formal report to be adopted. It is pointed out that the recent serious passenger ship losses which occasioned the inquiry need not give rise to exaggerated views of the problem, as it applies to British passenger ships, which, for many years, have been free from serious fires at sea, and rightly enjoy the benefit of a long tradition of efficient discipline. During the past year stringent regulations to safeguard against fires on board ship were adopted, however, by several foreign Governments.

The Trials of the Arcwear.

THE loaded trials of the Isherwood Arcform steamer "Arcwear" took place on Monday, January 22nd, over the Polperro measured mile off the Cornish coast, after which the ship left for Buenos Aires with a cargo of coal. She will return with a grain cargo. On the voyage round from Hull an average speed of 11·15 knots was recorded over a period of twenty-four hours, with only partial superheat. During Monday's trials eight runs over the measured mile were made, and an average speed of 12·1 knots was recorded, the highest speed being 12·12 knots. This result for a ship designed for a service speed of 11 knots is a very satisfactory one. Sir Joseph Isherwood states that the trial results have exceeded his expectations, and are much better than the Tank tests had led him to anticipate. The design of the hull and propelling machinery is such that an increased cargo space of 240 tons has been obtained, compared with a ship of the same 7000 tons deadweight capacity, while a 20 per cent. saving in coal consumption, as compared with a normal design of steamer, is also promised. The actual voyage results will be awaited with keen interest by shipowners. A description of the machinery of the "Arcwear" was given in our last issue. On the endurance trial the vessel carried 6850 tons deadweight on 9085 tons displacement, and attained a speed of 11·15 knots with 1417 I.H.P. at 64·44 r.p.m. and a coal consumption of 20 tons, giving an Admiralty constant of 425—a remarkably good figure—and a coal coefficient of 30,100.

The French Liner L'Atlantique.

ON Monday, January 22nd, the Seine Commercial Court delivered its long-awaited judgment on the case of the burnt-out hull of the "L'Atlantique." The decision given was that the ship cannot be repaired, and that the underwriters must bear the whole of the costs, which include the payment of 100 million francs on account of the all risks policy, a further 70 million francs covered by the total loss insurance, and the legal costs. The Court found itself in agreement with the report of the experts, which, it will be recalled, was outlined in a Journal note of December 1st. In the hearing of the case it was mentioned that a tender for the repair of the ship at a cost of £1,225,000, or below 100 million francs at the time it was made, had been submitted last year by Harland and Wolff, Ltd. The decision is not entirely unexpected, and it seems likely that an appeal will be made to a higher court. Meanwhile, the hull of the "L'Atlantique" continues to occupy the Homet dock at Cherbourg, for which a daily charge of 7000f. is being made. The total dock charges amount to over a million and a quarter francs to date, and it does not seem likely that the ship will be removed for some weeks to come. It is presumed that the dock costs will be added to those already payable by the losers of the action. The judicial inquiry into the cause of the fire is still going on.

Shipbuilding and Engineering Trade Unions.

As recorded in a last week's Journal note, the conference of Shipbuilding Employers' Federation representatives and members of the shipyard trade unions, on the question of the creation of a new class of ship welders, held in Edinburgh on Wednesday, January 10th, was adjourned until Friday, January 19th. No steps were taken, however, to bring about a settlement before that date, and the conference may now be looked upon as closed. All the stages of conference procedure having now been exhausted, a deadlock exists. It now rests with the employers to take the next step, but it is not anticipated that any crisis will be created. On the engineering side a joint conference of representatives of the Engineering Employers' Federation and the Amalgamated Engineering Union, along with other unions, has been arranged for February 15th, when the unions' demand for the establishment of a forty-hour week without loss of pay will be discussed. A central committee of the unions has been established, and it has made application both to the engineering and the shipbuilding employers. The forthcoming conference is, however, arranged with the engineering employers only, and so far no similar arrangement has been come to with the shipbuilding employers.

The Development of the Parsons Steam Turbine.

No. IV.

(*Continued from page 65, January 19th.*)

The First Geared Turbo-alternator.

IN February, 1896, a step was taken which was destined to point the direction for developments of the utmost importance in later years. This was the introduction of gearing between the turbine and the generator, in order that each might be designed to run at a favourable speed. De Laval, in Sweden, had been compelled to adopt this course for all the turbo-generators of his design, since their first appearance in 1886, for the simple de Laval turbine with its single wheel necessarily ran at a speed for which no useful purpose could be found. There was not the same compulsion in the case of the Parsons turbines because the principle of multiple expansion which was their essential characteristic enabled an efficient turbine to be built for a speed suitable for the generator.

FIG. 25—GEARED TURBINE IN FORTH BANKS POWER STATION, 1896

Indeed, the fact that 623 Parsons direct-coupled turbo-generators had been supplied by the beginning of 1896 proved that gearing was far from being a necessity. Nevertheless, the advantage of being able to fix both turbine and generator speeds independently of one another was obvious. The first Parsons turbine to drive its generator by gearing was a machine of 150 kW, supplied to the Newcastle and District Electric Lighting Company in February, 1896, this company thus having the credit, for the second time, of contributing towards a new development. The turbine in question ran at 9600 revolutions per minute and drove its alternator at 4800 revolutions per minute, producing single-phase current at 1000 volts and 80 cycles. It was designed to work with saturated steam at 70 lb. gauge pressure to exhaust into a condenser with a vacuum of 26·8in. Figs. 25 to 27 illustrate the arrangement of the set as well as some details of the gearing. Its performance on test is given in Table I.

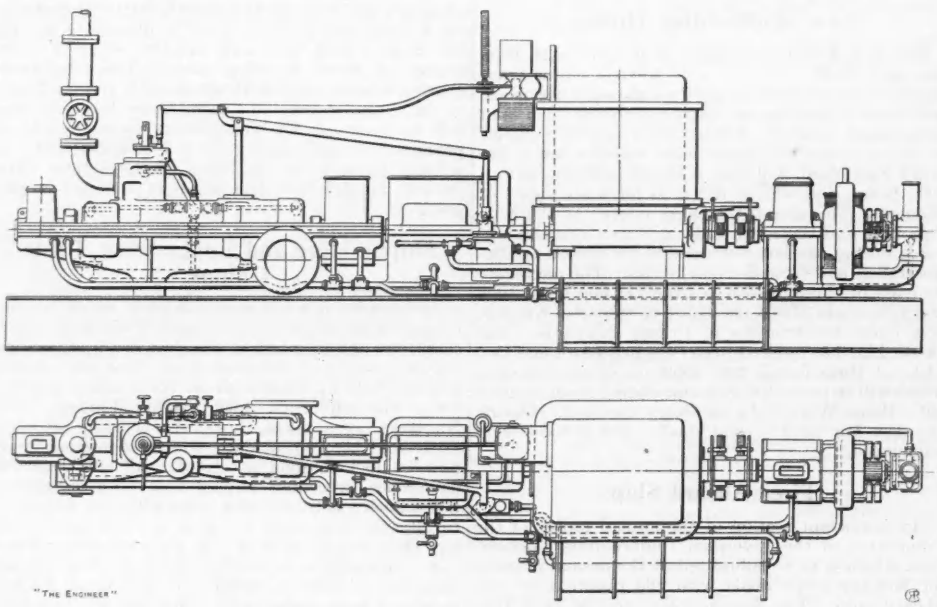


FIG. 26—FORTH BANKS 150 KW GEARED TURBO-GENERATOR

The year 1896 was also notable in the history of the Heaton Works, for the dispatch of the first turbo-alternator to America. The machine was designed for an output of 120 kW at 5040 revolutions per minute, single-phase current being supplied at 1000 volts. It was taken over to the United States by the late Mr. S. F. Prest, who succeeded Sir Charles Parsons in 1931 as the chairman of the Parsons Company, and by Mr. Frank Hodgkinson, who ultimately became chief turbine engineer to the Westinghouse Electric and Manufacturing Company, which, as licencees of the Newcastle firm, did so much to develop the Parsons turbine on the other side of the Atlantic.

The turbine of this unit, although of the standard parallel-flow design, was remarkable in many ways. A section through the machine is reproduced in Fig. 28, part of the rotor being also shown separately in Fig. 30. It will be seen from the illustrations that the blading was carried on no less than five drums of different diameter, and, further, that each of these drums was balanced by a separate dummy piston.

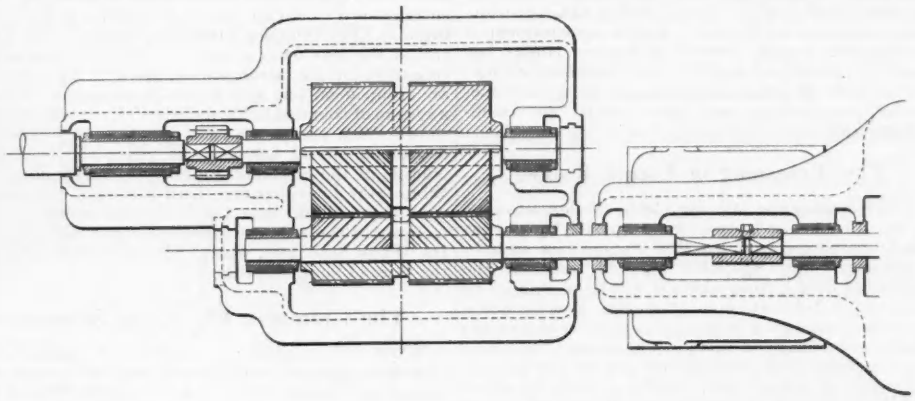


FIG. 27—ARRANGEMENT OF REDUCTION GEARING FOR 150 KW SET

Two of the drums were solid with the spindle, the three larger ones towards the low-pressure end being formed by separate steel castings mounted on the spindle by means of brass bushes. The smallest of the dummy pistons was made solid with the spindle, but the remaining four were constituted by a single steel casting with appropriate steps in its diameter. The grooves for the labyrinth packing of these dummies were cut from the solid, so far as the rotating portions were concerned, but the corresponding fixed grooves were turned in brass segments, dove-tailed and keyed into the metal of the casing, as shown in detail in Fig. 30.

It will be noted from Fig. 28 that the steam passages connecting each blade drum with its corresponding dummy piston were cast in the body of the casing. This method of construction is an interesting example of foundry practice, but experience soon showed it to be unsuitable, on account of the stresses caused by temperature which tended to distort the cylinder and to cause cracks in the ports. That the advantages of relieving the casing from stresses due to thermal expansion was recognised by Sir Charles Parsons at the time is, nevertheless, shown by the adoption of a practice, which, after falling into disuse, has been revived in the construction of modern turbines. This practice consisted in cutting through the flanges of the cylinders between each bolt hole and the outside edge, so as greatly to minimise the stresses which the relatively cool flanges would otherwise have imposed on the hotter cylinder. That a precaution now considered essential in large high-pressure turbines should have been practised in this early machine is yet another example of the foresight of the inventor. In the machine in question the whole of the metal between each bolt hole and the edge of the flange was removed, as shown by the dotted drawing of the flange superposed on Fig. 28. In modern practice there is merely a narrow saw cut between the hole and the edge, so that the bolt head and nuts are more fully supported, but the principle is exactly the same and the results identical. The revival of the idea came about with the fuller realisation of the fact that turbine cylinders should approximate as closely as possible to symmetrical rigid tubes, and though the flanges at the central joint have perforce to be heavy with correspondingly heavy bolts, the distortion to which they might otherwise give rise can be minimised by cutting through the bolt holes in the manner described. The extent to which designers have approximated to the ideal of a symmetrical rigid tube for turbine cylinders will be evident when we come to the consideration of recent machines.

TABLE I.—*Tests of 150 kW geared turbo alternator at the Forth Banks Station of the Newcastle and District Electric Lighting Co., October 26th.* 1896.

Load kW	Revs. per minute	Vac. at turbine	Total steam per hr. lbs.	Lbs. steam per kW. h.	Lbs. steam per E.H.P.	Remarks.
150·33	4700	26½	3484	23·17	17·28	Baro. 29.3in.
72·84	4700	26½	1950	26·77	20·0	Press. of steam at turbine 70 lbs/in².
38·97	4700	26½	1150	29·51	22·01	
0·175	4600	26½	437	—	—	

The little machine of 1896 was the first turbine ever commercially employed in the United States,* if we except some very small machines constructed by Professor Sweet on the lines of the original aeropile of Hero. A second machine was sent from Heaton to the United States in 1902. This was a 350 kW turbo-dynamo for the Pensylvania Salt Co., and it is of interest because it has recently been acquired for the collection of historical exhibits in the Edison Institute of Technology at Michigan. These machines were the forerunners of an enormous industry, in a new field protected by natural and artificial conditions, and the rate of development may be judged from the fact that within thirty years the Westinghouse Company was building machines of no less than 160,000-kW capacity. Owing partly to commercial arrangements and partly to the conditions just referred to, few turbines could be imported from Europe, though it may be mentioned that Messrs. Parsons and Co. supplied a 25,000-kW machine—the largest and most efficient in the world at the time—to Chicago in 1912, and a further 50,000-kW unit in 1923. Reference will be made to these in due course.

Before the end of the last century the value of a low exhaust pressure as a means of increasing the steam economy of turbines was fully realised, and efforts were made, especially in marine practice, to reduce the drop of pressure between the final blade row of the turbine and the tube surface of the condenser. In 1899 Mr. Parsons took out a patent for an arrangement in which a condenser and turbine were actually parts of the same structure so that there was no exhaust passage at all between them. The problem of reducing the back pressure was never lost sight of by him, as will be clear from a consideration of the developments in design, which will be referred to later.

During the same early period of development much

* The turbine patents of George C. Curtis, date from 1896, and the General Electric Company of Connecticut commenced building turbines under them in 1900;

attention was also paid to the improvement of high speed direct current generators as the limitation of such machines with regard to output was being severely felt. One of the great difficulties was the severe sparking at the brushes which was liable to occur with any change of load and necessitated a changed brush position for every particular load. It was noticed, however, that the displacement of the brushes required to secure minimum sparking varied approximately as the load of a dynamo. The steam pressure at the inlet to the turbine blading also varied with the load, hence the idea of an automatic brush adjustment gear, operated by the steam pressure in an auxiliary cylinder, suggested itself. Such a device was patented in 1900 and was used commercially. It was found, however, to have the drawback that the action was not quick enough to anticipate sparking altogether, more especially during rapid load fluctuations. Other solutions to the problem will be dealt with in due course.

THE ELBERFELD TURBINES.

Among the turbines which have become historical as marking notable advances in size and efficiency, the two 1000-kW machines supplied to the City of Elberfeld in Germany in the year 1900 have few rivals. The City Corporation decided to adopt turbine machinery on the advice of the late Sir W. H. Lindley, its consulting engineer, protecting itself by an extremely stringent specification of performance and verifying its fulfilment by means of exhaustive tests carried out by a board of continental engineers of the highest standing. The courage of the Corporation—for it needed courage in those days to order turbine machinery of such a capacity, even with the safeguards adopted—was abundantly justified by the results. Mr. Parsons was given a chance to show what his invention was capable of, and the thoroughness of the tests proved beyond question that the steam turbine was unrivalled for power station service.

Preliminary tests were run at the Heaton Works before the turbines were dispatched, Sir W. H. Lindley and Professor Weber coming over specially from Germany to supervise them. It was in connection with these tests that an accident occurred which, though not serious in itself, might have had the effect of setting back progress for some years, happening, as it did, at such a critical stage in the development of turbine machinery when confidence could so easily be destroyed. The incident, described by Dr. Gerald Stoney as "one of the biggest knock-out blows that Mr. Parsons ever received," consisted in the stripping of the blading of the high-pressure turbine

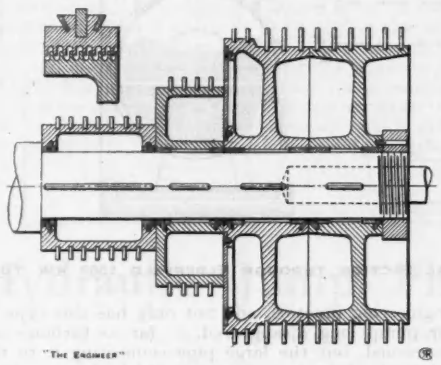


FIG. 30—PART OF ROTOR OF 120 KW TURBINE

of the first unit to be tested. The accident was caused by the mismanagement of the separately fired superheater. The steam temperature became excessive and the blading went. In those days the fact that brass, especially if containing a trace of lead, had a brittle point at about 460 deg. Fah., was not appreciated. Furthermore, the cylinder had not been designed in the best way to avoid distortion, for balancing passages were cast in it—a practice long since recognised as dangerous and abandoned. The quickness with which repairs were effected earned the admiration of the German engineers, and the tests were completed in January, 1900, a week or so only after the accident. The low-pressure blading had also suffered a little, but it was decided to leave it as it was, the intention being to re-blade it in Germany if the official tests there indicated that such a course was advisable. When the official tests were carried out, however, the machine with the damaged low-pressure blading proved actually to be slightly more efficient than the other one.

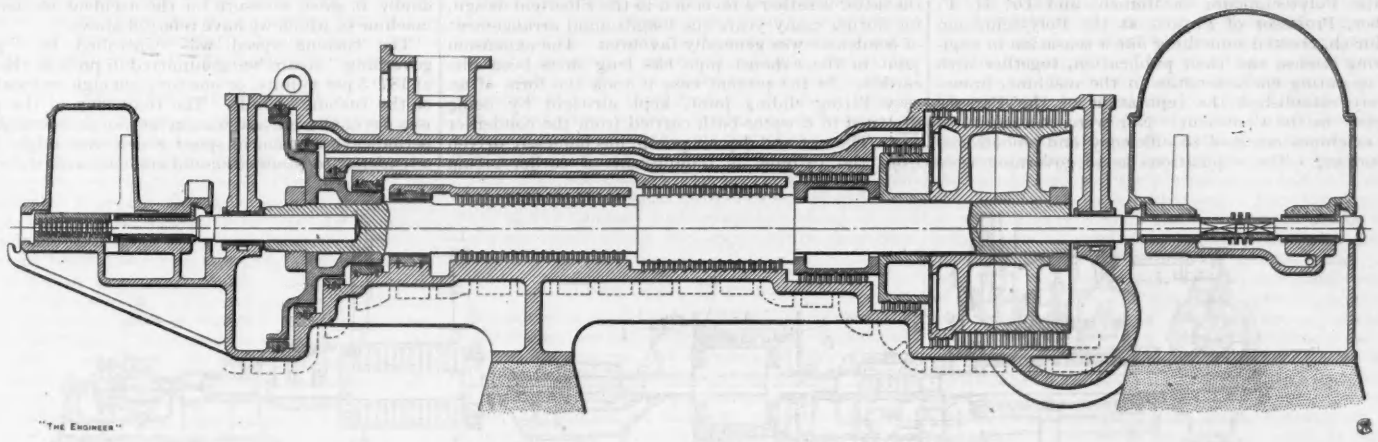


FIG. 28—SECTIONAL ARRANGEMENT OF 120 KW TURBINE FOR AMERICA

Each set was designed for an economical capacity of 1000-kW and an overload capacity of 1250 kW. Single-phase current was generated at 50 cycles and 4000 volts. The speed was 1500 revolutions per minute. The specified steam pressure was 11 atmospheres absolute at the stop valve, with a superheat of 50 deg. Cent., while circulating water was to be supplied to the condenser at 18 deg. Cent., and at the rate of 430 cubic metres per hour. On the official tests the specified superheat was not obtainable, an average of 14·3 deg. Cent., instead of 50 deg. Cent. existing at the stop valve. Under such conditions, the following figures of steam consumption were obtained :—

	Average load, actual. Kilowatts.	Total steam per hour. Kilogrammes.	Steam per kWh. Kilogrammes
Preliminary trial	1,172·7	9,589	8·26
Overload	1,190·1	10,485	8·81
Full load	994·8	9,092	9·14
Three-quarter load	745·3	7,542	10·12
Half load	498·7	5,695	11·42
Quarter load	240·5	3,774	15·31
No load—			
Alternator excited	0	1,844	—
Alternator not excited	0	1,183	—

If the steam consumptions are corrected to accord

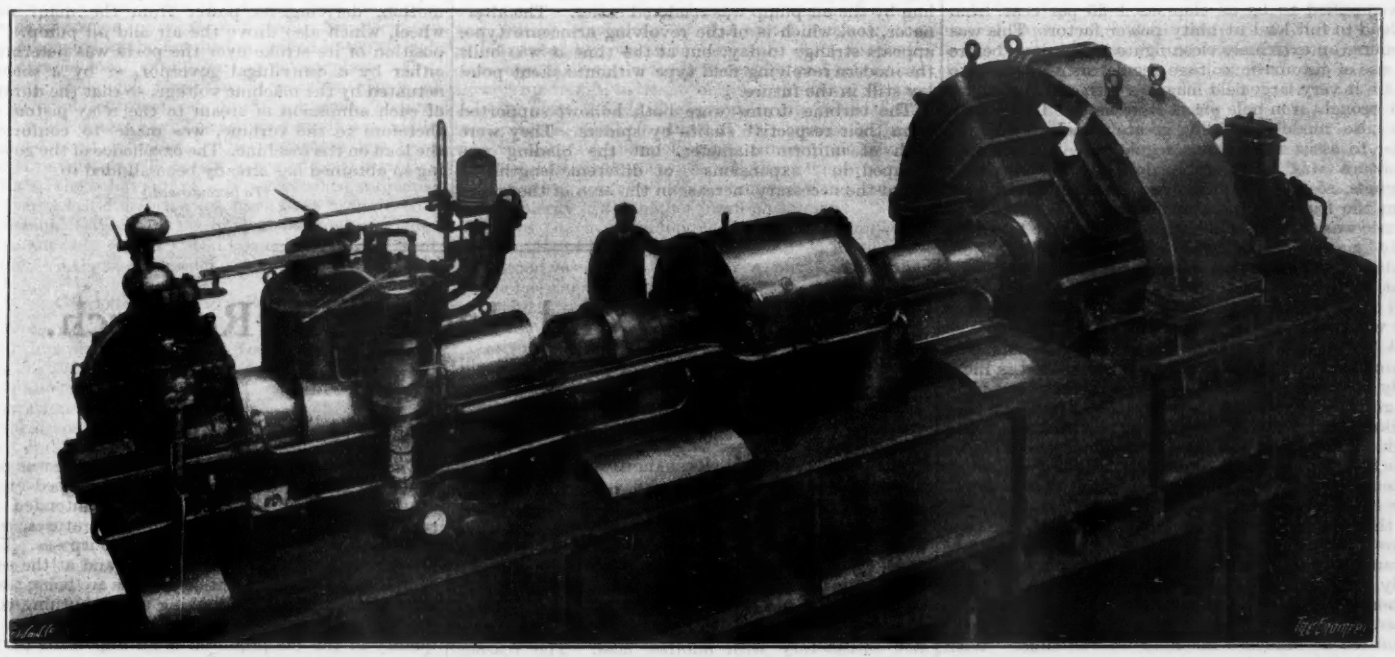


FIG. 29—THE ELBERFELD 1000 KW TURBO-GENERATOR

with the specified conditions of the tests, the figures are as follows :—

Load. Kilowatts	Guaranteed steam per kWh. Kilogrammes.	Actual steam per kWh. Kilogrammes.
1250	—	8·63
1000	11·0	9·19
750	11·3	9·99
500	12·0	11·41
250	14·0	15·28

The actual performance was thus noticeably better

than that guaranteed, and, indeed, a consumption of 8·63 kilos., or less than 19 lb. of steam per kilowatt-hour delivered at the switchboard, was rightly considered an achievement of extraordinary merit. The figures, certified to by a Commission appointed by the City of Elberfeld, consisting of Sir W. H. Lindley, Herr M. Schröter, Professor of Engineering at the Polytechnicum of Munich, and Dr. H. F. Weber, Professor of Physics at the Polytechnicum of Zurich, created something like a sensation in engineering circles, and their publication, together with the operating characteristics of the machine, immediately established the reputation of the Parsons turbine on the Continent. Nor were the merits of the machines confined to efficiency and smoothness of running. The stipulations as to governing were very strict, but the results obtained surpassed the guarantees. The rise in speed from full load to no load was only 3·6 per cent. Sixteen per cent. of the load could be suddenly thrown off with a temporary rise in speed of 1 per cent., and 63 per cent. could be suddenly removed with a temporary rise in speed of 1·9 per cent. The machine settled down to permanent increases of speed of 0·4 and 1·3 per cent. in the respective cases. The electrical governor maintained the voltage constant within 1·1 per cent.

The inherent voltage regulation of the alternators was specified to be as close as 1·25 per cent. from no load to full load at unity power factor. This was of course an extremely close figure in the days before the use of automatic voltage regulators. In order to obtain it very large field magnets with cast iron yokes and wrought iron pole pieces were used, The air gap was also made unusually great, namely 1 1/16 in., in order to assist the voltage regulation. The rotating armature was considerably longer than the field magnets, so that the brass end caps were well away from the fringers of the magnetic field. The consequence was that, although the end caps were free from eddy currents, the rotor plates themselves were heated by such currents induced by the fringes of the field. To get over this difficulty the ends of the poles had to be extended with laminations in order to cover the whole of the iron parts of the rotor.

A photograph of one of the Elberfeld machines is reproduced in Fig. 29, and the construction is more fully illustrated in Fig. 31, which gives a complete longitudinal section of the unit. The first thing that strikes the eye is that the turbine comprised separate high-pressure and low-pressure cylinders, a feature which has since been so largely followed and even extended by turbine makers generally, that it forms one more example of the prescience of the originator in these early days. If, in the light of our present knowledge, it seems curious that a two-cylinder arrangement was thought advisable for a unit of only 1000 kW, it should be remembered that the Elberfeld machines were more than double the capacity of any turbine constructed up to their time, and were regarded as immense machines at the time. With improved materials and methods of manufacture, the principle of building turbines with more than one cylinder fell into disuse for a time, but as greater outputs were called for its advantages became more evident, and since its revival in the 5000 kW Lots-road machines in 1910 it entered into current design, and to-day is regarded as generally essential for all turbines of over 20,000 kW. The enormous bed-plate shown in the longitudinal section was due to Sir W. H. Lindley, who insisted on having it. He afterwards confessed to Mr. Parsons that he had been quite wrong.

Reference to the sectional arrangement drawing, Fig. 31, shows many features which have been retained in principle, if not in detail, in turbine machinery of to-day, while reminding one in other respects of the changes that have taken place in turbine practice since the Elberfeld machines were put to work in 1900. The condenser set cross-wise to the turbine in the basement is typical of modern practice, though the latter is rather a reversion to the Elberfeld design, for during many years the longitudinal arrangement of condenser was generally favoured. The expansion joint in the exhaust pipe has long since been discarded. In the present case it took the form of an easy fitting sliding joint, kept air-tight by being drowned in a water-bath carried from the condenser top. The wet and dry air pump, mechanically driven from the turbine, is reminiscent of earlier steam engineering practice, and not only has this type of air pump long disappeared, so far as turbines are concerned, but the large pipe connecting it to the relatively distant condenser would be by no means consistent with modern ideas. Another feature which modern practice would not countenance was the drowning of the lower tubes in the condenser by means of the condensate. The idea which was advocated for many years by leading condenser makers was to cool the condensate as much as possible. Its vapour pressure was therefore reduced and its handling by the air pump was rendered easier. The alternator, too, which is of the revolving armature type, appears strange to-day, but at the time it was built the modern revolving field type without salient poles lay still in the future.

The turbine drums were both hollow, supported from their respective shafts by spiders. They were each of uniform diameter, but the blading was grouped in "expansions" of different lengths to afford the necessary increase in the area of the steam annulus. The axial thrust of each drum was balanced by three dummy pistons, each taking the thrust due to the corresponding group of blades. Equalising ports connecting the various expansions with their respective dummy pistons were cored out of the turbine casings, a practice soon abandoned as favouring distortion of the casings, and responsible, no doubt, in great measure for the accident to the first machine to which we have referred above.

The turbine speed was controlled by "gust-governing," steam being admitted in puffs at the rate of 187·5 per minute, or one for each eight revolutions of the turbine spindle. The frequency of the puffs was never altered, and was, in fact, so chosen that any periodical variation in speed which they might have a tendency to produce should coincide with the cyclic irregularity of the steam reciprocating engines of the station, so as to ensure satisfactory parallel working of the alternators of the respective types of prime mover. To provide more steam when the load increased, the duration of each puff was made longer, so that at maximum load the steam entered in a practically continuous blast. The steam was admitted to the turbine by a double-beat valve, the periodic movement of which was effected by a pilot valve and steam relay. The pilot valve was kept in oscillation mechanically by a crank and lever motion, deriving its power from the main worm wheel, which also drove the air and oil pump. The position of its stroke over the ports was determined either by a centrifugal governor, or by a solenoid actuated by the machine voltage, so that the duration of each admission of steam to the relay piston, and therefore to the turbine, was made to conform to the load on the machine. The excellence of the governing so obtained has already been alluded to.

(*To be continued.*)

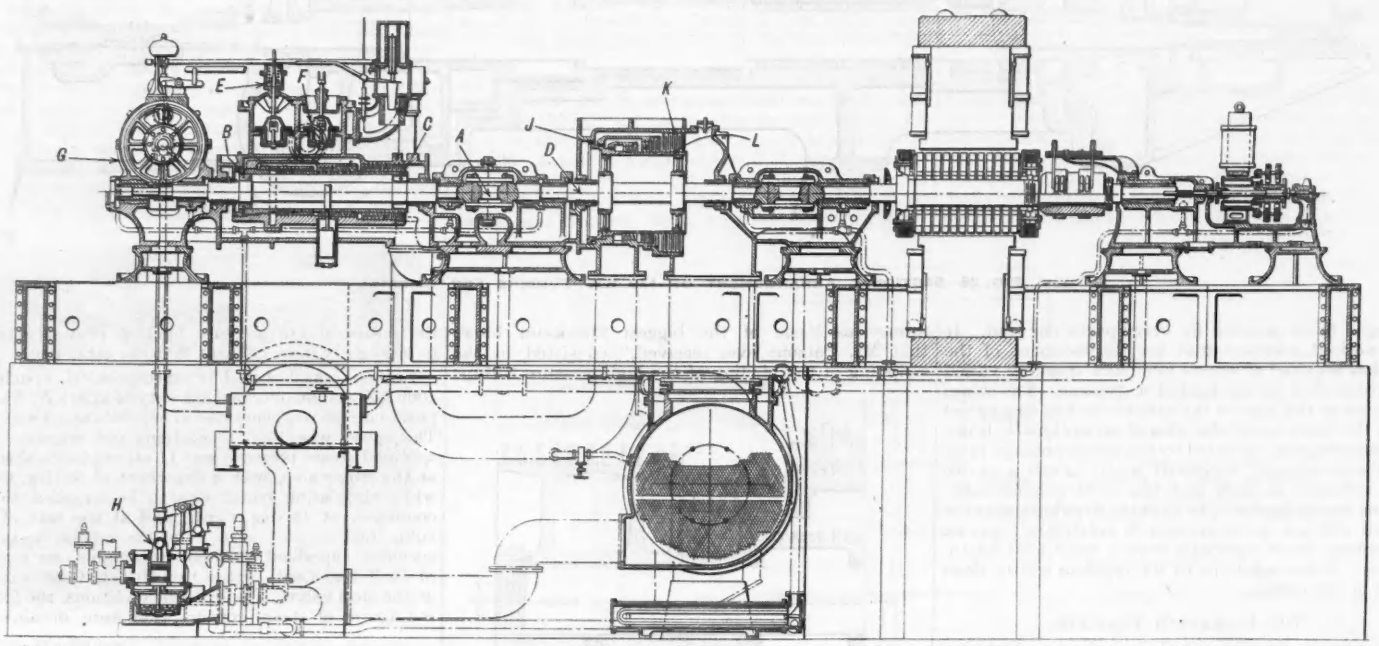


FIG. 31—LONGITUDINAL SECTION THROUGH ELBERFELD 1000 KW TURBO-GENERATOR SET

Scientific and Industrial Research.

No. II.

(*Concluded from page 75, January 19th.*)

FUEL RESEARCH.

Purification of Coal.—The main practical problems of coal cleaning are how to deal with very small sizes, and how to remove the dust and fine clay, &c., that accumulate in the water used for washing the coal. Both these problems are being investigated, and substantial progress has been made. Progress in the past has been retarded by the fact that a process that will work perfectly satisfactorily in one case is not satisfactory with another coal. The reasons for this are being gradually determined. An example is the use of a flocculating agent, such as gelatin, to increase the rate of settlement of slurry in washery water; in one case, an addition of about 2½ lb. of gelatin per ton of solids in the washery water increased the rate of settling by about five times, whereas with another slurry the rate was almost halved. A new type of pneumatic cleaner for small coal has been designed at the Sheffield Coal Survey Laboratory where it has been tested on a small scale with satisfactory results. A larger model is now being constructed at the Fuel Research Station, where it will be tried out on an intermediate scale.

Carbonisation.—During the year a report was published on the narrow brick retorts developed at the Station. These, though originally intended for carbonising at so-called "low" temperatures, seem capable of being used for a variety of purposes. They are now being tested for durability, and at the same time a number of different coal seams are being tested for their suitability for making a free burning coke. The effect of the conditions of carbonisation on the quality of the tar produced is an important part of the work. The work on horizontal gas retorts of the type still largely used in the gas industry is nearing completion. It has been shown that it is quite practicable to admit steam to the retorts during a portion of the carbonising period, as is common in practice with vertical retorts, and so increase the gas obtained per ton of coal. It has been found possible to increase the gas from a typical coal from 75 therms per ton without steam to 85 when steaming. The conditions essential for success, and the limit to which steaming is practicable, are being studied.

Hydrogenation.—The treatment of materials with hydrogen under comparatively high temperatures

and pressures forms a means of providing fuel oils and motor spirit from tars or direct from coal in greater quantities than any other known method. Some tars are particularly amenable to this treatment, and a study of the essential factors is being continued. Progress has been made towards the final design of a converter for dealing with tar on a semi-commercial scale, but it has been found advisable to obtain more experience with a smaller plant before coming to a final decision on the design. Experiments are also continuing on the hydrogenation of coal.

METALLURGICAL RESEARCH.

Behaviour of Materials at High Temperatures.—Work was carried out at the National Physical Laboratory in accordance with the programme recommended by the Supervisory Committee of the Metallurgy Research Board. Creep tests on four magnesium alloys suggested by the Air Ministry have been completed, the results indicating that the order in respect to creep strength is the reverse of the order in respect to tensile strength. Several commercial low alloy steels suitable for superheater tubes are being tested in regard to creep properties, whilst satisfactory progress is being achieved in the co-operative work with the Kaiser Wilhelm Institut für Eisenforschung, which is designed to correlate the results of short-time creep tests as carried out at that institute with the long-time tests made at the National Physical Laboratory. The investigation of the nature and mechanism of creep has been extended to include pure iron and commercially produced forms of iron and mild steel. The temperature and condition of test have been correlated with the mode of failure and structural changes occurring during prolonged heating under load. The work is being extended to include investigation of the tendency of age-hardening alloys to creep, and for this purpose a copper alloy containing 3 per cent. nickel silicide has been selected for examination. The age-hardening characteristics of this material have now been studied. The research for new ferrous materials is being continued at the National Physical Laboratory under the supervision of the Joint Committee of the British Electrical and Allied Industries Research Association and the National Federation of Iron and Steel Manufacturers. Work has been carried out on additional low-carbon steels manufactured by various processes, and a further study has been made of the relationship between carbon content and creep properties. The effect of heat treatment on these steels and on a similar series containing 0·5 per cent. and 1·0 per cent. molybdenum has also been studied and the creep properties of some of the steels are found to be markedly improved. Tests for corrosion in flue gases have been carried out on the majority of these steels, with special reference to the effects of sulphur dioxide in the flue gas. The apparatus designed for the investigation of corrosion in superheated steam has been put into operation, and specimens of the steels which were considered in the creep examination are being exposed at pressures up to 1000 lb. per square inch and at temperatures up to 600 deg. Cent.

Cracking of Boiler Plates.—The prolonged stress tests on mild steel strips at 300 deg. Cent. have now been in operation for nearly five years. No specimens have fractured at the notched or drilled holes, though considerable local extension has taken place. Preliminary prolonged time tensile tests on pieces of annealed plate immersed in 30 per cent. sodium hydroxide solution have been carried out in a specially designed steel cylinder. The apparatus has been further developed. The tests on the effect of corrosive media on the behaviour of boiler steel when subjected to severe plastic deformation have been brought to a conclusion. Work on corrosion fatigue of boiler plates has only recently been begun, and is at present confined to the construction of the machine.

WATER POLLUTION RESEARCH.

Survey of the River Tees.—The comprehensive scientific survey of the river Tees which was begun in April, 1929, has been completed. In the non-tidal reach above Yarm, the work has consisted mainly of observations of the effects of sewage pollution on the chemical composition of the river water and on the fauna and flora. At the same time the factors which influence the rate of self-purification of the river from sewage pollution have been systematically studied. It has been shown that the rate of self-purification is dependent mainly on temperature and increases rapidly as the temperature rises. There is no doubt that the fundamental information obtained will be of considerable value in considering the effects of discharges of sewage and sewage effluents on other rivers and in assessing the quantities of such effluents that a river can receive without being seriously polluted. In the middle portion of the estuary, from Stockton to Cargo Fleet, numerous industrial effluents and large quantities of untreated sewage are discharged. As a result the concentration of dissolved oxygen in the water is considerably reduced, especially during the warmer summer months. In addition, the industrial effluents discharged from coke oven plants in large quantities contain cyanide in sufficient concentration to render the estuary water toxic to fish. Methods of reducing the toxicity of such effluents have been demonstrated in laboratory experiments and on a larger scale. One of the most important results of the survey is that future installations of coke ovens to be erected in the Tees area will be designed in such manner that little or no polluting effluent need be discharged.

River Mersey.—A beginning has been made in an investigation of the effects of the discharge of crude sewage into the estuary of the river Mersey on the amount and hardness of the solid matter deposited in the estuary. The subject is of considerable importance to the local interests concerned, as extensive dredging of the estuary has been necessary for many years to preserve a navigable channel, and it has been stated that the character of the material deposited is such that dredging is often difficult. The investigation is being carried out in response to a request from and at the sole cost of the Merseyside local authorities and the Mersey Docks and Harbour Board and associated bodies. Laboratories and motor boats at Liverpool have been equipped for the work, and preliminary hydrographical, chemical, and biological observations and experiments have been made.

LUBRICATION RESEARCH.

Experiments on a lubricated bearing subjected to oscillating motion have been continued at the National Physical Laboratory and a report on the observations made with a commercial lubricating oil has been submitted. The report includes a comparison of the observations of the same oil with boundary friction and Deeley friction, as well as a comparison of the friction of the same journal when rotating at very slow speeds. The friction for the oscillating or rotating shaft is a constant amount less than the boundary friction up to 70 deg. Cent., but above this temperature the friction falls instead of increasing as in the case of boundary friction. At the highest rates of oscillation (15 cycles per minute) there appeared to be evidence that the friction was decreasing with speed. The machine has been modified and tests are being made at speeds up to 1000 cycles per minute. The experiments on the effect of speed, load, and clearance upon the seizing temperature of a journal bearing have been concluded. The general effect of the variables has been investigated down to a speed of 40 r.p.m. Some further work, which will form a separate investigation, is required over the speed range from 0 to 40 r.p.m. Preliminary observations show that at very low speeds abrupt seizure does not occur and the bearing will run without seizure after the coefficient of friction has risen to the order of 0·05. The observations obtained during the investigation are being analysed in order to ascertain the limits of true fluid friction under various combinations of load, speed, and clearance. The preliminary observations on the aspect angle and excentricity of a journal bearing have been concluded and an investigation of the variations in these quantities for a lubricated bearing has been commenced. The variables included are load, speed, temperature, and clearance. The observations have been commenced on a bearing with a total clearance of 2 mils, and so far it appears that the maximum horizontal shift of the centre of the journal is one half the radial clearance for all loads and speeds. The temperature at which this maximum shift occurs may not be the same under all conditions. Some preliminary trials have been made of a pressure gauge within the journal in an attempt to obtain a continuous record of the pressure in the oil film. The optical system has now been improved and the trials are proceeding. The trials have not been carried sufficiently far to prove the method to be practicable, but they are encouraging. A sample of rustless steel has been obtained for preliminary experiments upon the conditions under which a journal of this material can be lubricated. This particular steel is stated to have failed to run in a ring-oiled bronze bush.

ATMOSPHERIC POLLUTION.

The second period of three years for which the Department accepted responsibility for co-ordinating the observations of atmospheric pollution carried out by local and other authorities throughout the country and for carrying out researches incidental thereto, expired on March 31st last. After a review of the position, it was decided that the work should form a normal part of the activities of the Department, on the conditions—originally laid down—that not less than £500 be contributed by the co-operating authorities to the cost of the central services and that the Department's contribution should not exceed £500.

Hydraulic Jump Phenomena at Denver.

By IVAN E. HOUK, M. Am. Soc. C.E.*

UNUSUAL hydraulic jump phenomena occurred at several places along the improved channel of Cherry Creek at Denver, Colorado, during the floods of August 3rd and September 9th, 1933. The jump formations occurred at the same places on the two dates, and were present during all higher stages of the floods. Moreover, they remained practically stationary as regards position throughout both rising and falling conditions of the water surface, the primary standing waves moving only short distances downstream as the velocity increased and retreating slowly upstream to their original positions as the velocity decreased. The jumps were unusual for two reasons, first, because of the relatively high velocities in the channel at the times of maximum flow, and second, because of the comparatively high standing waves which accompanied the dissipation of energy in the higher jump phenomena.

One of the most pronounced hydraulic jumps in the 3¼ miles of improved channel occurred just below the Broadway-street bridge, at a place where the channel changes abruptly from a completely lined, rectangular section, built on a comparatively steep gradient, to a partially lined, somewhat larger, rectangular section, built on a relatively flat gradient, the enlargement in cross-sectional area being made by a vertical drop of about 4ft. in the bottom of the channel. The photographs reproduced herewith and on page 98 show the appearances of the jump during three different stages on August 3rd, 1933; also the appearance of the channel after the flood had passed. The first view, on page 98, shows the upstream side of the jump at the time of maximum stage, and the two succeeding views the downstream side at the same time. One of the views reproduced herewith shows the jump about two hours later. The appearances of the jump on September 9th, 1933, were about the same as on August 3rd, except that the standing wave, at the time of maximum stage, was somewhat smaller than on August 3rd, because of the smaller rate of discharge during the passage of the flood crest. The two remaining photographs reproduced herewith show the appearances of the empty channel after the flood of August 3rd, looking upstream and downstream from the approximate situation of the jump. Incidentally, the first view on page 98 shows an interesting freak of Nature. Near the top of the wave can be seen the profile of a man's face. The image is facing the approaching flood water and his hair and whiskers are streaming down the channel, as though they were being blown downstream by a strong wind.†

The photographs taken at the time of maximum discharge show that the crest of the highest standing wave was about 15ft. above the bottom of the trough along the upstream side of the wave, and about 5ft. higher than the sidewalks along the edges of the channel. However, no flooding occurred along the banks at that time. Apparently, the water was moving downstream so quickly that it could rise to the crest of the wave and then fall back into the channel again before it had time to spread out laterally. The photographs also show that the higher standing waves tended to be concentrated in the central portion of the cross section, as a result of the relatively high velocity and the accompanying high frictional retardation along the sides of the channel. The second view on page 98 shows that a definite secondary wave, almost as high as the primary wave, was situated a short distance downstream from the primary wave. The jump disturbances on August 3rd presented an unusually formidable and repulsive appearance during the higher stages of the flood, because of the presence of about 10 per cent. of black silt in the flow.

Unfortunately, no accurate data regarding velocities and depths of water above and below the jump illustrated in the photographs were obtained on either August 3rd or September 9th. However, float measurements, made during the passage of the flood crest on August 3rd, indicated a maximum rate of discharge of 16,000 second feet. Flood flow studies, made after the passage of the flood of September 9th, indicated a maximum rate of discharge of 10,000 second feet on that date. Calculations made for the maximum stage on August 3rd, based on the maximum rate of discharge, estimated depths of flow, and the known width of channel of 80ft. between the inside faces of the side walls, show conclusively that the mean velocity was greater than the critical at places just above the standing wave shown in the photographs, and less than the critical at places just below. The disturbances illustrated must, therefore, have constituted a real hydraulic jump. Apparently, the depth of water was about 8ft., and the velocity about 25ft. per second, just above the standing wave; and the depth about 11·5ft., and the velocity about 17·4ft. per second, just below the standing wave. Studies of flood surface elevations, velocities,

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† The image is somewhat less obvious in the reproduction than in the original photograph. In the original every detail of the face from the nostrils to the half-shut eyes is clear and startlingly lifelike.—ED. THE E.

and channel gradients above the situation of the jump, show that the total head available was great enough to overcome the frictional resistances and develop the velocity of 25ft. per second.

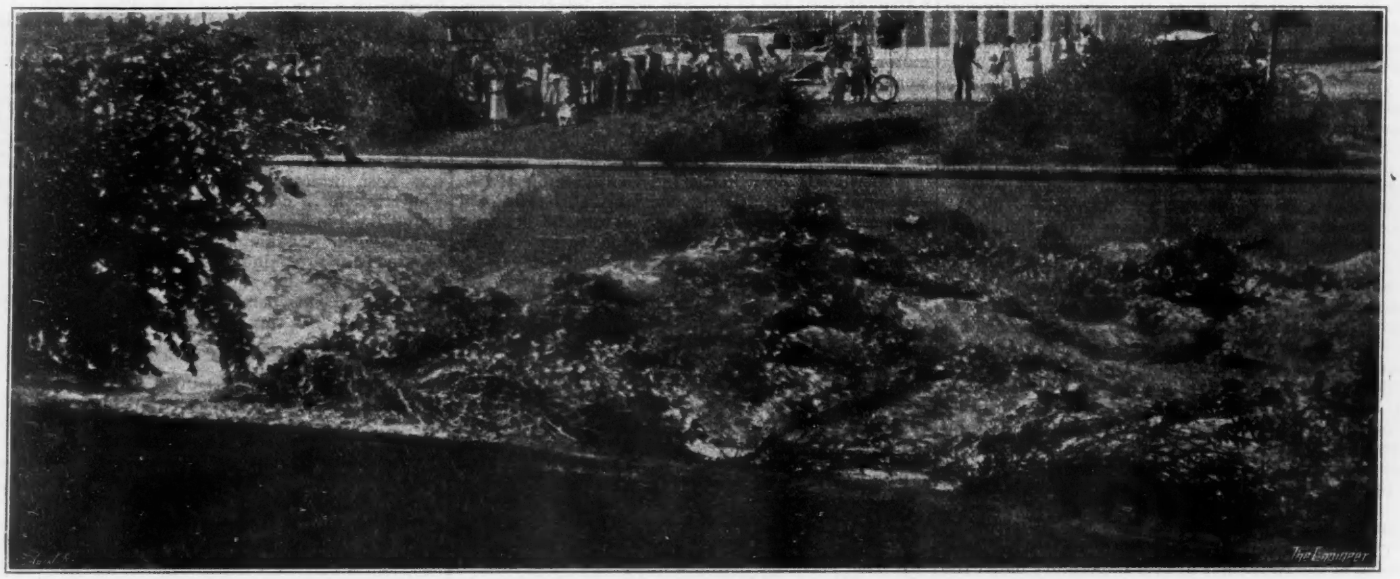
A relatively steep bottom gradient, 1·676 per cent., extends upstream from the vertical drop at the lower end of the completely paved section to the Broadway-street bridge, a distance of about 340ft. Some contraction of flood cross section, with a corresponding speeding up of velocity, occurred at Broadway and at other bridges along the improved channel. During the early stages of the floods the gradient of 0·488 per cent., which is steeper than the gradient needed to maintain a velocity of 17·4ft. per second with a depth of flow of 11·5ft. Consequently, the velocity increased gradually as the water moved downstream, until it reached a value greater than the critical. It then decreased abruptly again, through the medium of the hydraulic jump, this process being repeated several times in the 2 miles of improved channel below Broadway. Similar conditions of flow existed during the lower stages on August 3rd, and also during the flood of September 9th. These conclusions were checked by actual observations during both floods, as well as by theoretical investigations.

The greater number of hydraulic jump formations occurred at places where vertical drops or other irregularities exist in the bottom of the channel. The vertical drops are remnants of small weirs, built more than thirty years ago as a part of the original channel improvement, the purpose of their construction being to create pools along the stream bed and thus to beautify the channel during low-water periods. The weirs were removed after the disastrous flood of July 14th, 1912, in order to increase the channel capacity during future flood discharges. The original improvement had been designed for a maximum flood flow of about 10,000 second feet, whereas the 1912 flood reached a peak discharge of approximately 12,000 second feet. It was estimated that the removal of the weirs would provide about 120 square feet of additional flow area along the bottom of the cross section, and would increase the safe channel capacity by about 3000 second feet. No floods of a size comparable with the flood of 1912 occurred from that time until the summer of 1933, when the floods of August 3rd and September 9th reached maximum discharges of 16,000 and 10,000 second feet respectively.

Computations of the heights of the hydraulic jumps during the 1933 floods, using the standard jump formula developed on the basis of Newton's Second Law of Motion, would hardly be justified in this case, because of the lack of sufficiently accurate data, and because of the fact that the channel slopes and vertical offsets in the bottom gradients tend to vitiate the applicability of the equation. Nevertheless, studies of critical flow conditions and approximate calculations for the jumps shown in the photographs, and for similar disturbances which occurred further downstream, have convinced the writer that the hydraulic jump forms in improved channels substantially when and where indicated by theoretical considerations of velocity, depth, and slope. The investigations of the Cherry Creek hydraulic flow conditions have also convinced the writer that improved channels, if at all practicable, should be planned so that the mean velocities during all stages of flow will be either definitely and continuously below, or definitely and continuously above, the critical values for the corresponding depths of flow, the former being preferable whenever possible. Naturally, this criterion for design is much more important in cases where relatively large discharges must be carried at comparatively high velocities.

The unusually high standing waves in the improved channel of Cherry Creek during the floods of August 3rd and September 9th, 1933, caused no serious damage at Denver, inasmuch as they resulted in no overflow of the banks at the places where they occurred. Such flooding as did take place resulted from abnormally high flood surfaces at situations both above and below the jump formations. However, a channel improvement design which permits the occurrence of standing waves of a magnitude as great as those shown in the engravings is certainly not to be desired.

Standing waves, similar to those illustrated, but probably more of a sand wave nature than a true hydraulic jump, occurred at several places along the natural channel of Cherry Creek above Denver, during both of the 1933 floods. In some instances, the water was deflected into the air on slopes so



CONDITION OF THE HYDRAULIC JUMP TWO HOURS AFTER THE PASSING OF THE FLOOD CREST, AUGUST 3, 1933

hydraulic jump occurred immediately below the vertical drop in the channel bottom. Naturally, it increased in size and gradually moved downstream as the flood surface rose and the velocity increased. It then decreased in size and gradually moved back upstream as the flood surface fell and the velocity decreased. The primary standing wave was situated about 75ft. downstream from the vertical drop at the time of maximum flood height on August 3rd, and about 40ft. downstream at the time of the intermediate stage shown in the view taken two hours after the passing of the flood crest. The secondary standing wave occurred about 40ft. downstream from the primary wave at the time of maximum stage.

The change in channel lining below the vertical drop consists of the omission of the concrete floor in the central part of the cross section. Some of the bottom paving slabs along the sides of the channel below the drop were dislodged during the flood of August 3rd, and moved toward the centre of the channel, as shown in the photographs taken after the flood had receded. During intermediate stages of the flood the tops of some of the slabs could be seen rising and falling above the water surface, crosswise of the current, as the water surged around them, first lifting them on edge, then allowing them to sink back toward the bottom until an added impulse was supplied by the raging current. The bottom of the channel below the vertical drop has a

UPSTREAM AND DOWNSTREAM VIEWS OF CHERRY CREEK CHANNEL AFTER THE FLOOD

steep that the waves broke and the water fell in an upstream direction. Some of the waves may have been caused by necessary reductions in velocity through the critical stage. However, it is believed that most of them were caused by erosion of the channel bottom, lodging of trees in contracted sections, presence of bridge sub-structures, and other obstructions along the wetted perimeter. Advancing flood waves, somewhat similar to a tidal bore, also moved down the valley during the rising flood stages. These waves were especially pronounced during the flood of August 3rd, but were also observed during the flood of September 9th. The flood of September 9th was caused by scattered downpours of rain on small tributary drainage areas from 10 to 30 miles south of Denver. It was a typical cloudburst flood, but was not large enough to cause serious damage within the city. The flood of August 3rd was caused by the overtopping and sudden collapse of the east half of the 92ft. Castlewood rock-fill dam—an antiquated irrigation structure built about 35 miles south of Denver in 1890. The failure of the dam and the sudden release of the 5000 acre feet stored in the reservoir was caused by an unusually heavy run-off resulting from a cloudburst rainfall of about 8in. in three hours on parts of the tributary drainage area above the dam.

The flood of August 3rd arrived at Denver in two waves about forty minutes apart. The first wave, which apparently originated when the reservoir water began running over the spillway at the dam, was only from 3ft. to 6ft. high. The second wave, which was caused by the partial collapse of the structure, was from 12ft. to 15ft. high. The two waves moved down the valley at about the same speed, approximately 6 miles an hour, the second wave being retarded more by valley storage effects than the first, as a consequence of the higher stages in the creek channel at the time of its passage and the accompanying greater overflow of agricultural lands. The front of the second wave looked much like the downstream side of the highest standing wave shown in the engravings, but its top probably did not reach above the level of the banks. Moreover, it was moving steadily down the channel instead of remaining in one place. It was followed by a full cross section of moving flood water, the trough at the upstream side of the waves shown in the engravings being practically absent. The maximum height of the flood at Denver was reached about an hour after the arrival of the second wave. Because of the relatively large valley storage effects it is doubtful if the maximum flood stage at Denver would have been appreciably lower if the Castlewood Dam had not been in existence at the time of the flood. Calculations based on the rate of filling of the reservoir just before the failure of the dam indicate that the maximum rate of inflow was about 30,000 second feet, or about 300 second feet per square mile from the area of about 100 square miles on which the cloudburst rainfall occurred. The maximum rate of flow in the canyon below the dam, resulting from the sudden release of the reservoir storage, was about 126,000 second feet.

Communication over Power Systems.

By H. E. HUTTER, A.Am.I.E.E.

THE installation of an adequate communication system is essential if effective co-ordination of the activities of a large electric supply company is to be achieved. The various units, such as power-houses and sub-stations, must be in constant touch with each other.

The essential requirements of any such system are simplicity in operation and flexibility in lay-out, unaffected by system disturbances and especially available at times when the main power system is in trouble.

The use of a voice-communication system appears to be mostly favoured, but the problem of line telephone communication over a transmission line is very difficult. The telephone line is often supported on the same towers as the transmission line, and is consequently exposed to the electro-static and magnetic fields from the power conductors.

Telephone lines may be placed on separate poles down the right of way when this is available. The cost of this scheme is, however, higher than that of suspending them from the line towers. The line is still exposed to interference from the main conductors, and this tends to make it very noisy. Alternatively, a line may be leased from the telephone company or Post Office, the route of which may be very remote from that of the power line.

The carrier current telephony system was developed to overcome these disadvantages of the telephone. The power conductors are utilised as a channel for a high-frequency voice-modulated wave. Communication can be conducted between any number of stations on the system. The fragile telephone conductor is abolished, and the interference problem is no longer considered. An earth on a line will not interrupt the service, which is only interfered with by a continuous lightning discharge, and many instances could be quoted when communications over the carrier system have continued when all other lines have ceased working owing to storms.

The only system in operation in this country of which the writer has knowledge is in Scotland. The maximum length of line over which the system will work is practically unlimited. The Arkansas Power Company, of the U.S.A., operates over a line 460 miles long.

FIG. 3—B.T.H. 10-WATT SINGLE FREQUENCY TELEPHONE EQUIPMENT

The system is almost identical with radio, except that a metallic conductor is utilised to prevent the dissipation of the waves in all directions. The carrier wave has a frequency of 8–150 kilo-cycles per second, depending on the system used. The action of the operator speaking into his telephone causes variations of the carrier wave directly proportional to the sound waves constituting his voice. This process is termed modulation, and the wave thus modulated is impressed upon the line through suitable coupling apparatus.

The reverse of the above process is effected at the receiving end. The modulated wave, by a process termed demodulation, is made to vibrate the receiver telephone in a manner similar to the sound vibrations initiated at the sending end.

The apparatus to be installed at each station consists of a radio transmitter and receiver together with accessory equipment and a suitable arrangement for coupling to the transmission line. Protective equipment prevents any risk to operators or equipment by inductive effects or accidental contact with high voltage conductors.

The receivers at all stations are in continuous operation, calling being effected by dialing as with the automatic telephone. A bell will ring at the called station either for a specified time or until the call is acknowledged. Several systems are in use whereby the calling is done *viâ* a loud speaker. This saves the time of a load despatcher on a large system, as in an emergency all stations can be called without dialing or waiting for the call to be acknowledged.

A number of systems are in use, each differing in certain respects. The duplex type permits two-way conversation at the same time and is practically universal. This type may be either single frequency, wherein a single frequency is used for sending and reception, or duplex using a different frequency for each operation.

The system is inoperative if there are open switches on the line unless efficient by-pass equipment is installed or an inefficient by-pass is formed through a straight capacity to some nearby conductors. The gap between power lines running closely parallel, but of different voltage, can be bridged, and submarine cables also do not offer any obstruction.

The carrier wave can be prevented from dissipating itself over branch portions of the line by the use of frequency blocking equipment. This apparatus consists of an inductance coil shunted by a variable condenser, which resonates the combination at the same frequency as the carrier wave and thus offers the highest impedance to a wave passing down a branch line. Fig. 1 illustrates the apparatus required when two installations are located at one station.

The coupling to the line is invariably effected by coupling condensers. The Westinghouse system, now discontinued, utilised aerials 2000ft. long. Four distinct types of condensers are made—the dry porcelain type, suitable for voltages below 15 kV; the condenser type, suitable for any voltage; the oil-filled tank type, suitable for 220 kV; and the American G.E.C. cable type, which is superseding the tank type above 110 kV—see Fig. 2.

The cable condenser is built up from a loop of oil-filled cable, the two ends being bound together and terminated in a single bushing fitted with a suitable terminal. The provision of an oil reservoir ensures that the cable always remains oil filled. The carrier equipment is attached to the lead sheath of the cable. The maximum capacity of the condenser used at a terminal station will not exceed 0·001 mfd., while, on the other hand, depending on the conditions, it may be as low as 0·00033 mfd.

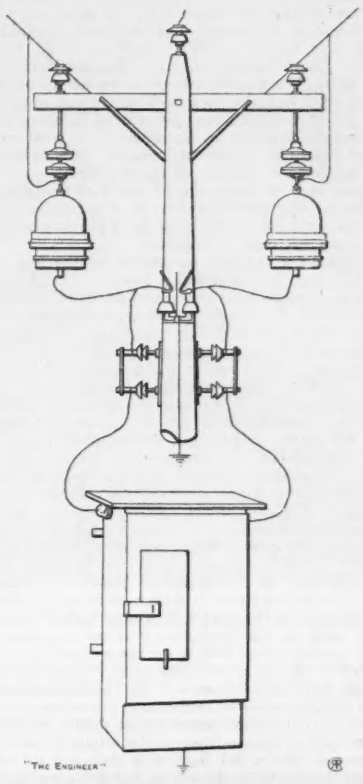


FIG. 4—ATTACHMENT OF PATROL SET TO OVERHEAD LINES

The condenser type, apart from the oil-filled tank example, is constructed in a number of different forms. The unit may be mounted inside an oil-filled bushing for floor mounting. Alternatively the unit may be attached to a string of cap and pin insulators, by which it is suspended from the sub-station structure either indoor or outdoor. The latter type meets with much favour on the Continent.

The extensive transmission line schemes in operation in the United States has resulted in the development of small sets for use by patrol men and at unattended sub-stations from which communication may be required.

The apparatus—Fig. 3—is entirely self-contained, the supply being obtained from dry batteries mounted in the all-metal cabinet. Removing the hand set from the switch hook places the equipment in operation; the dial, forming part of the telephone hand set, provides a convenient means of calling stations equipped with selective ringing, and stations with loud speaker calling can be signalled instantly either by voice or by a code calling button. The illustration Fig. 4 shows the method of attaching a patrol set to overhead lines.

The distance over which communication can be maintained depends on the line construction and on the complexity of the system network. A range of 70 miles can be obtained on a 44-kV line, increasing with a higher-voltage line.

Coupling to the line is made by condensers to two phases, the lead from each condenser passing through a fused disconnecting switch of 15-kV rating direct to the cabinet. A double-pole horn gap is connected between the two condensers as a safety measure.

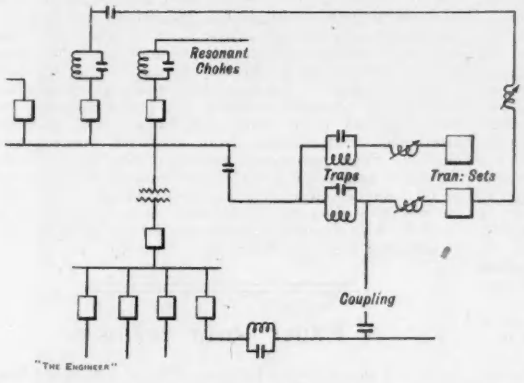


FIG. 1—APPARATUS FOR TWO INSTALLATIONS AT ONE STATION

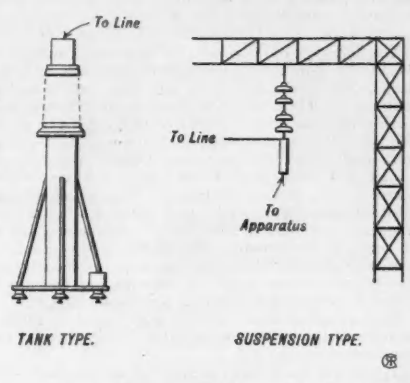


FIG. 2—TYPES OF CONDENSER COUPLINGS

THE Department of Scientific and Industrial Research has just issued a "Summary of Current Literature on Water Pollution." There are 125 abstracts, British and foreign, and the brochure can be obtained from the usual sources at the price of 2s.

Concrete Roads.*

THE use of concrete in road construction is rapidly becoming more popular, and the reason is not difficult to understand. To stand up to fast heavy traffic a road crust or pavement must have great compressive strength, whether the weather be hot or cold, wet or dry. Concrete has this characteristic. It is cheap, and can be laid by comparatively unskilled labour. Even if the concrete be badly made and laid, it can be repaired economically with little interference with the traffic; at the worst, it has usually some value as a foundation for a more expensive surface.

It is well known that when unreinforced and unrestrained concrete, laid in the form of a slab, sets and dries, it contracts about $\frac{3}{8}$in. in 100ft.

A concrete slab will expand and contract due to change of temperature, the coefficient of expansion being 0·0000055 per degree Fahrenheit, this applying equally to reinforced and unreinforced concrete. It is also known that an unreinforced concrete slab, even if it attains a tensile strength of 300 lb. per square inch after setting, will, if anchored at the ends, crack with a fall of temperature of 27 deg. Fah. These characteristics of concrete would appear to be disadvantages for road construction, but it will be shown that the reverse is so. The action of change of temperature in causing expansion and contraction naturally takes effect first on the upper part of the slab, and therefore conduces to diurnal and seasonal variations of warping. Records of the movement of long slabs have recently been taken by the Ministry of Transport and by road authorities in America, and it has been found that in hot weather the slabs tend to hog off the foundation at the centre, and during cold weather to curl up at the edges.

The concrete in setting and hardening shrinks horizontally and vertically. The centroid of all the horizontal shrinkage forces lies in the horizontal plane midway up the slab. The anti-shrinkage forces set up by friction with the road bed obviously act in a much lower plane. Hence the horizontal forces are out of balance, and the slab warps at the edges, or, alternatively, in so attempting, develops widely spaced surface cracks. It is evident that whilst the surface concrete is free to shrink, the base is restrained, and the structure is therefore unstable. The addition of reinforcement to, or a preponderance of reinforcement in, the lower stratum of the slab only serves to aggravate the want of balance.

The thinner a concrete pavement is, the less are the shrinkage and anti-shrinkage forces out of balance. Success in concrete road construction, therefore, does not lie necessarily in thicker pavements and an increased weight of steel reinforcement, but rather in firm uniform road bases on which are placed thin, perfectly balanced, anchored and non-warping pavements wherein impact stresses will be reduced to a minimum.

As a defect in itself, warping is sufficiently detrimental in causing uncomfortable travelling for all classes of traffic, but whilst it is in that respect a disease, it is also a weakness leading to the far more serious ailments of chamfered and broken joints, large cracks, &c. Warping is a sympton of eventual disintegration, for warped pavement must crack to re-bed itself. The deterioration of concrete roads is not so much due to fair wear and tear caused by traffic, as to the pounding of traffic on warped surfaces.

Construction and expansion joints are generally admitted to be a source of weakness in a concrete road. A wheel load on the centre of a slab is distributed in a circular area on the formation; if on the edge of the slab, to a semi-circle, and if on the corner of a slab, to a quadrant. In effect, the efficiency of a slab is reduced to 25 per cent. at the corners. By the methods of crack control advocated herein, expansion joints can be entirely eliminated, and where construction joints are necessary the load can be transmitted to the adjacent slab. Reinforcement in the upper part of a slab will do much to alleviate the strain at the edges, but the general practice of placing single-layer reinforcement in the lower part of the slab is useless for this purpose.

The following experiment serves to make clear the tendency of slabs to warp. Three slabs, 14in. by 11in. by 1½in., composed of clay and gauged cement, were cast on glass plates with cast iron surrounds. Small steel hoops, 2in. in diameter and spaced ½in. apart, were embedded in each of these slabs. In case 1, with the hoops laid directly on the glass plate, the slab warped up at the edges, and the base was permeated with vertical cracks reaching midway up the slab. In case 2, with the hoops bedded in the surface, the slab became hogbacked, minute cracks appearing on the upper surface and extending downwards half-way through the slab. In case 3 the rings were placed very slightly above the midway plane. The slab dried out perfectly flat, and minute cracks occurred at both the top and bottom of the slab.

This experiment illustrates that the position of reinforcement, or plums and restrainers of any kind, is all-important if the equilibrium of the slab is to be maintained. It will be noted that in the perfectly flat slab the centre of gravity of the displacers was set slightly above the midway plane, to allow for the slight friction of the under side with the glass upon which it was cast.

PRACTICAL APPLICATION AND CRACK CONTROL.

The primary essential of a perfect concrete road is a road base which is hard, compact, and uniform. If not naturally so, it should be made so by suitable excavation, filling, and rolling. If the formation is of clay, it is undesirable to lay a thick layer of ashes thereon, preparatory to laying the concrete. Such a porous layer of ashes on a water-tight base often serves as a reservoir for surface water, which may pump up through joints in the pavement under the action of traffic. If this occurs, then sooner or later ashes and clay will be pumped up. The better way is to sprinkle the base with ashes or hard core and endeavour to make the road base a conglomerate of clay and ashes, or clay and hard core, and thus eliminate the chance of a water-bearing stratum below the pavement.

Every effort should be made to attain maximum friction between the pavement and road base by scarifying or by suitably indenting or trenching the base. The next step is to control the cracks in the upper part of the slab. A slab 6in. thick is ample for most purposes. A simple method of controlling the shrinkage of the upper part of the slab is to lay steel hoops of 24in. diameter close together, 1in. below the surface. If the hoops be made of steel rods, $\frac{7}{8}$in. in diameter, the weight of steel per square yard will be about 7 lb. A better way is to make them of corrugated strip steel, 2in. in width by 18 gauge, and lay them close together with the upper rim 1in. from the surface. In this case the weight will be about 5½ lb. per square yard. A further alternative is to lay the hoops of 2ft. diameter by 2in. by 18 gauge, spaced 6in. apart by distance pieces, 6in. in length by 2in. in depth by 18 gauge. The weight per square yard of steel will then be approximately 4 lb.

The first type of hoop used by the Essex County Council, the Poplar Borough Council, and others was of hexagonal shape, 2ft. across the flats and made of 1½in. by $\frac{1}{8}$in. strip steel. These gave excellent results, but it was considered that the weight could be reduced. Circular rings, 24in. and 30in. in diameter, of steel strip, 3in. by 18 gauge, were then tried by the Surrey County Council and the Ministry of Transport. These hoops, however, resembling barrel hoops, lacked rigidity, and when being placed in position could be pressed into ovals and other undesirable shapes. Consequently, they were less efficient than circles in acting as non-distortable plums in the concrete. In recent roads this deficiency has been rectified by making the circular hoops rigid by corrugating the steel strip without increasing the weight per square yard.

On formations which are naturally good or can be made so by a heavy roller and suitable filling, there is no need for reinforcement.

Where the road base, in spite of all that can be economically effected, is of bad and non-uniform bearing capacity, as, for instance, over recently filled-in trenches, the reinforcing of the concrete should be undertaken thoroughly, that is, with double-layer reinforcement bound with diagonal shear members. This double-layer steel serves to take the stresses due to both flexure and contraflexure. The road base should be trenched, indented, or otherwise formed to key as effectively as possible with the base of the concrete and prevent the latter from moving. If the base of the concrete be firmly located and filled with minute shrinkage cracks, it follows that the diagonal steel members should be immovably fixed, as should the concrete in the upper layer at the arrises of the steel pyramids. Consequently, the upper part of the concrete slab should have some degree of crack control. Contrary to the usual practice, the lower layer steel should be of less weight per square yard than the upper layer, in order to get a better balance of the opposing shrinkage and anti-shrinkage forces, and to give tensional strength in the top of the slabs at the corners and edges, where tensile strength is required far more than in any part of the base of the slab. In actual practice it would appear that with double-layer reinforcement as described, complete crack control is not established.

Looking to the future, it would seem that, thanks to the excellent work done by the Ministry of Transport and the Bureau of Public Roads in the United States, we are now much further advanced in the theory and practice of concrete pavement construction. It is to be hoped that warped, incorrectly reinforced, free-moving, inefficiently jointed, slab construction will be superseded by continuous, anchored, crack-controlled, flexible, and therefore unwarpable, pavements, having the joints necessary for screeding and other constructional purposes properly interlocked and immune from excessive opening and closing. Such pavements, surfaced with large granite aggregate and periodically surface-brushed with thin tar or bituminous coatings to take the inevitable wear, will be free from excessive impact stresses and should vie in duration with the existing concrete streets of Edinburgh constructed over sixty years ago.

* Abstracted from a paper read by J. H. Walker before the Institution of Engineers and Shipbuilders in Scotland on January 16th.

PAPER PULP SCRAPER PLANT AND ROPEWAY

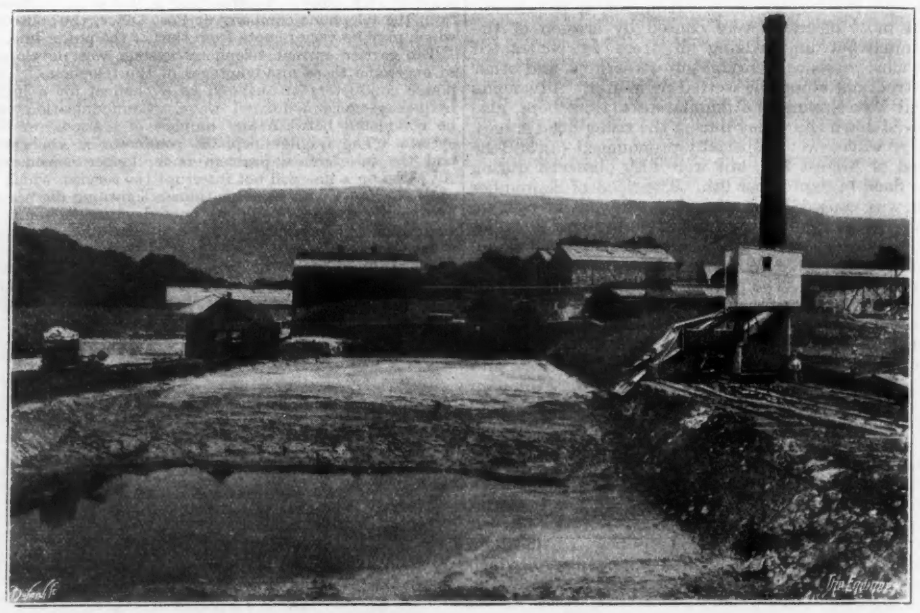


FIG. 1—ORIGINAL METHOD OF WORKING

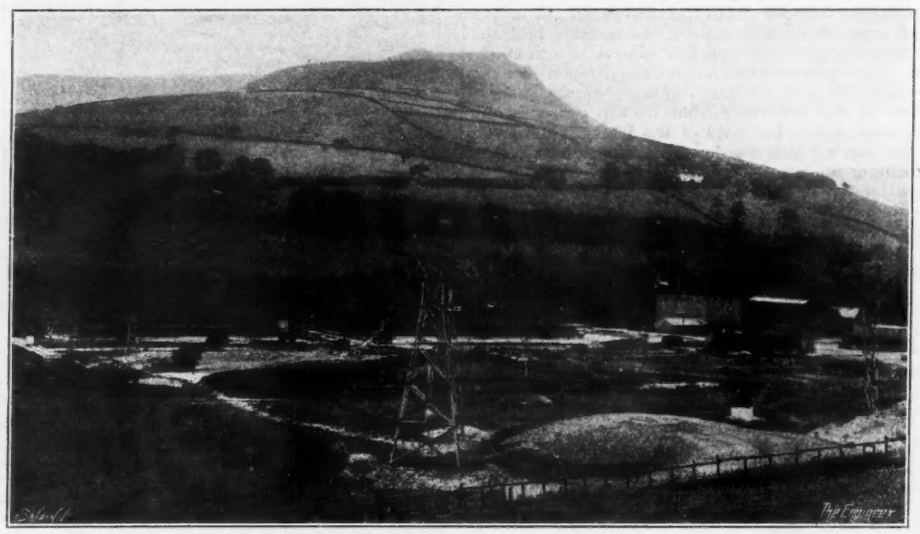


FIG. 2—THE RE-MODELLED PLANT

A Paper Pulp Scraper.

AT the paper mills of Messrs. Fletcher, at Greenfield, Yorkshire, the paper pulp refuse is run into settling ponds with a large quantity of water, and allowed to accumulate until it is fairly solid. It then has to be cleared out and dumped on vacant land to make room for more. At the time of its removal, it is about of the consistency of stiff porridge, and weighs about 65 lb. per cubic foot. The ponds, of which there are four, separated by narrow embankments, are approximately 80ft. wide by 200ft. long, and up to recent times were cleared out by the plant shown in Fig. 1, which was supplied by John M. Henderson and Co., Ltd., of Aberdeen, in conjunction with C. H. Johnson and Sons, Ltd., of Manchester.

A scraper bucket was dragged backwards and forwards

across the pond and dumped into jubilee wagons. The waste was then trucked away to empty land. It was found, however, that as business progressed the wagons could not get rid of the waste quickly enough, and the plant was remodelled, by the same firms, with the addition of a ropeway. Fig. 2 is a general view of the plant as it now stands.

The original scraper gear was retained, but, instead of working across the ponds, it was rearranged to work lengthways, as shown in the plan, Fig. 3. The headgear of the scraper was put on the main central wall of the ponds and tracks laid at the outside ends for the tail gears, each of which was provided with a pulley carriage and counterweight—see Fig. 5. A turntable was also installed at the end of the central track, so that the headgear could be turned round to face either way and work on any of the ponds, it being necessary only to re-reeve the haul-back rope.

The bucket, which is hauled backwards and forwards along the pond, is illustrated by Fig. 6. As will be seen, it has no bottom, and is open at the front, so that it fills up and the load itself takes the rubbing action on the floor. When it comes to the headgear end of the pond, it rides up on to a metal ramp attached to the gear, which prevents the load dropping out. This ramp, which is plainly shown in Fig. 4, rises to such a height that it commands the loading rail of the ropeway. The load is there tipped down a shoot into the skips of the ropeway. The drag-line bucket is then hauled back by the tail rope to get another load.

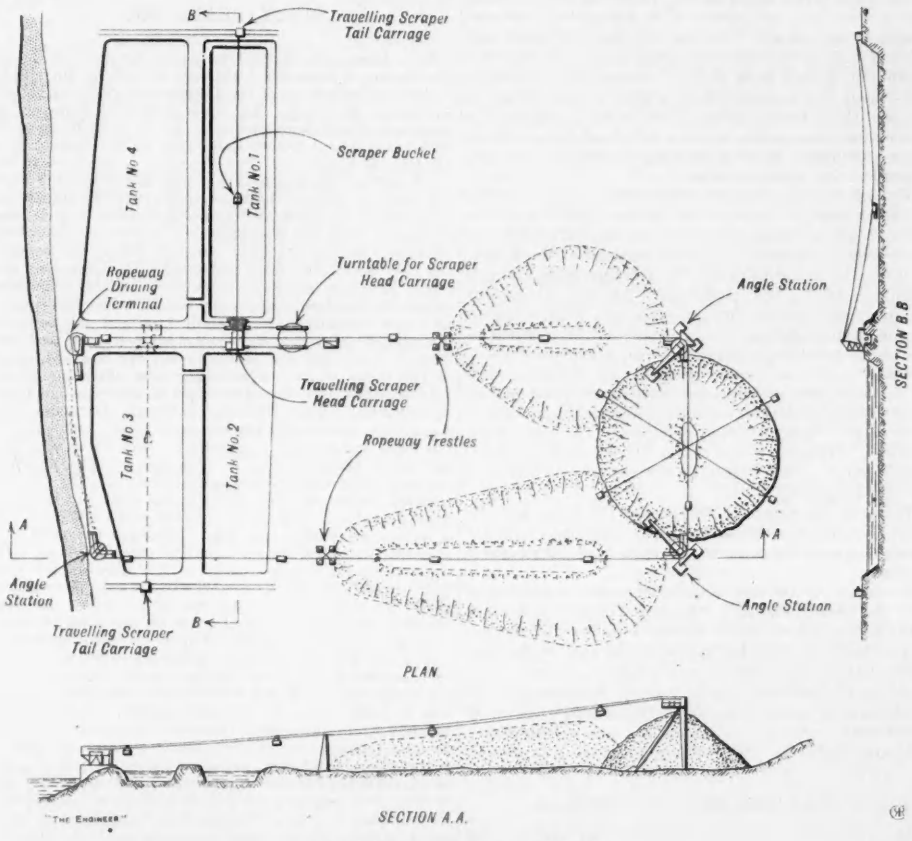


FIG. 3—ARRANGEMENT OF PLANT

The scraper is operated by a double-drum winch mounted on the head carriage, the operator's platform being raised above the winch, where he has a clear view of the work. The drums are engaged alternatively by friction clutches, and automatically applied brakes are fitted to maintain a suitable tension in the rope which is being overhauled. The bucket has a capacity of $\frac{1}{2}$ cubic yard, and travels when full at a speed of 225ft. per minute, and when empty at a speed of 450ft. per minute. The machine is able to handle 40 tons per hour. The winch is driven by an electric motor of 20 B.H.P., the current being supplied by a trailing cable. Hand gear is provided for travelling the head and tail carriages along the tracks.

The ropeway is of the double-rope type, and the skips pass along a loading rail at the centre of the track for the scraper head carriage. Uncoupling gear is fitted to the scraper carriage so that when a ropeway skip reaches the scraper it can be brought to rest under the shoot leading from the scraper ramp.

The ropeway buckets have a capacity of $\frac{1}{2}$ cubic yard, and one load of the scraper bucket fills each one. When it is filled the skip is again coupled to the hauling rope of the ropeway and is hauled along the rail to the carrying rope. A tipping frame supported on the carrying cable can be moved along from time to time as required. As the skip passes this frame the tipping catch of the skip is automatically knocked out and the skip discharges its contents, after which it passes on automatically round the angle stations and returns to the driving station. The whole plant is operated by three men, one for the winch, one for loading the ropeway skips at the scraper head carriage, and one at the driving terminal of the ropeway.

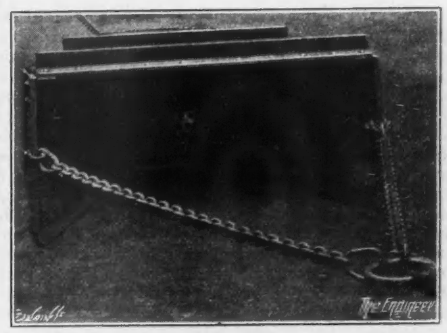


FIG. 6—SCRAPER BUCKET

FIG. 7—HIGH ANGLE STATIONS OF ROPEWAY

The total length of the ropeway is 1429ft. The rope travels at a speed of 240ft. per minute, and there are twelve skips. The spacing of the skips is 134ft., and the time intervals between skips is thirty-four seconds. The ropeway is driven by an electric motor of 12 B.H.P., and handles 40 tons per hour, the same capacity as the drag-line.

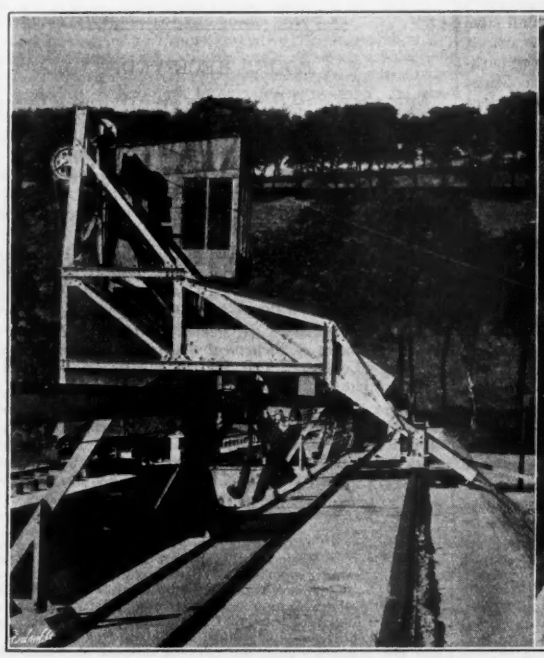


FIG. 4—HEADGEAR OF DRAGLINE

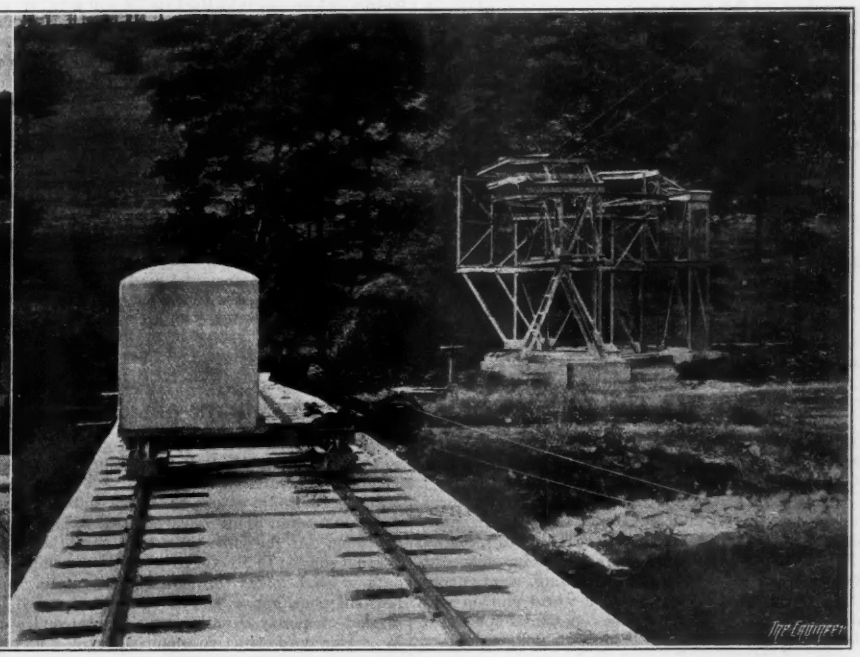


FIG. 5—TAILGEAR OF DRAGLINE AND ANGLE STATION OF ROPEWAY

Obituary.

LORD ABERCONWAY.

IT is with deep regret that we have to record the death, on Tuesday, January 23rd, of Lord Aberconway, who only last month retired from the chairmanship of John Brown and Co., Ltd. Lord Aberconway was in his eighty-fourth year and for a long time had held a leading position in British industry. Although he was trained as a barrister and did not enter industry until middle life, he rapidly achieved great success and became an outstanding figure in some of our largest iron and coal, steel, shipbuilding, and railway undertakings. During his career he was chairman of the Tredegar Iron and Coal Company, Ltd., the Metropolitan Railway Company, John Brown and Co., Ltd., of Sheffield and Clydebank, and the Sheepbridge Coal and Iron Company, Ltd., and also held positions on the boards of several other companies. He it was who helped to pilot the Metropolitan Railway Company through the difficult transition period during the change over from steam to electric traction, and he remained as chairman until the recent transfer of the company's interests to the London Passenger Transport Board. He was also instrumental in bringing about a financial association between John Brown and Co., Ltd., and Harland and Wolff, Ltd., and until about a month ago he continued to take an active interest in his firms. Lord Aberconway was an associate of the Institution of Naval Architects and a one-time President of the British Iron Trade Association. His death will be widely regretted in a large circle of personal and business friends.

EDGAR WORTHINGTON.

MECHANICAL engineers will learn with deep regret of the death of Mr. Edgar Worthington, who from 1898 to 1920, nearly twenty-three years, was Secretary of the Institution of Mechanical Engineers. He died on Tuesday, January 23rd, at his home in St. John's-gardens, London, in his seventy-eighth year. Edgar Worthington was the son of the late Samuel Barton Worthington, who was associated with the early days of railways, having been articled to Joseph Locke, George Stephenson's pupil and assistant. He received his education at Owen's College, Manchester, and obtained the B.Sc. degree of the Victoria University. His practical training was obtained in the L.N.W.R. workshops at Crewe, under Mr. F. W. Webb. At a later date he was employed in the erection of hydraulic machinery at Holyhead, and after occupying other railway posts he was given in 1880 the position of assistant works manager at Crewe under Mr. Worsdell. The next two years he spent in America and Canada, where he obtained a wide experience of railway and locomotive work. He returned to England in 1883, and for two years served as assistant manager to Mr. C. Dick at the Crewe locomotive works. In 1888 he joined the firm of Beyer, Peacock and Co., Ltd., of Gorton Foundry, Manchester, as assistant engineer and subsequently became managing engineer. In 1898 he was appointed the Secretary of the Institution of Mechanical Engineers, and in that post his courtesy endeared him to the members of the Institution, the numbers of which during his term of office increased from 2500 to 7500. He exercised, without doubt, a great and beneficial influence on the affairs of the Institution during an important period of its development. His brother, Mr. William Barton Worthington, was chief engineer of the Midland Railway and is a past-president of the Institution of Civil Engineers.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE THIRD DIMENSION.

SIR,—Air Commodore Chamier accuses me of pessimism, but I would plead only half guilty, for while I believe man will eventually fulfil his destiny in the words of the Air Force motto—"Per ardua ad astra"—I do feel that he is in real danger of losing the present round of the fight, unless or until he can balance his material advancement with a spiritual counterpoise—and quickly.

I cannot hold that admiration for man that your correspondent expresses; to me "Homo sapiens" seems to be as much "Sap" as "Homo," for, failing to recognise his limitations and to attune his rate of progress accordingly, while the existence of overcrowding, want, unemployment, and needless misery in a world glutton with food, goods, money and vast healthy spaces of undeveloped land, is surely a laughter-making exhibition for gods and men.

Man is but the trustee of his genius; he knows not whence it comes, but as surely as he begins to take to himself the credit of it, so it turns against him to his destruction, and it is doing so to-day. His "head" may be "bloody, but unbowed," in Henley's words, but it is his own fault for butting it against a wall which his senses show him to be there. And as to being "Master of his Fate and Captain of his Soul," rubbish! He never knows what morning he may not walk out of his front door to be knocked head over heels by a skidding taxi-cab; the boast, though high-sounding, is hollow to the core, while the limited command he has over his "soul" resolves itself into deciding which road he will choose in the succession of alternatives presented to him by Fate and which we call—Life.

The Third Dimension risk in the air and the uncontrolled speed of motor cars are two factors arising from our development and application of petrol power that serve admirably to illustrate man's folly; the failure to check uncontrolled speed on the roads has turned them into a shambles, the figures now approaching 300,000 casualties per annum! Failure to admit the additional risk imposed by the third dimension in the air over and above the normal risks of two dimensional movement has caused the incineration of thirty human beings in the last three weeks alone. This is not "progress"; it is insane race suicide, and the facts and figures admit of no argument. If aerial insurance rates have not yet responded, they must ere long.

My plea, useless, I fear, yet God knows earnest enough, is that we pause to consider how far the dangerous powers we have acquired are fit for general use. We have but one working hypothesis, viz., the survival of the fittest, tempered by Christian mercy to a beaten enemy and a helping hand to the underdog. All else is idealism and unworkable so far. We must, though, be fit, and keep fit, for all eventualities, but speed should be confined to the track, and flying to experts alone, whether service or sporting, and our whole approval to the discoveries we make should be tempered with more humility and more thought as to their useful and beneficent application. I recently overheard two youngsters talking. First speaker: "What's the use of this Everest flight stunt?" Second ditto: "Oh! just to tell Providence where it gets off, I suppose."

There you have exactly the spirit of the times, and the spirit that has wrecked successive civilisations, one after another, as each has acquired "swollen head," throughout the ages.

Let man, if he has a grain of sense, admit he is only the instrument of a "Cosmic Power," which has many names, but to which he owes humility and service, and without which he has no existence, and on the keystone of this civilisation we may yet save the arch; but to do so it is essential to note both the sequence and the combination expressed in the Royal motto—"Dieu et mon Droit."

DUBIOUS.

January 20th.

ALL-STEEL ROLLING STOCK.

SIR,—Though only an interested layman, I feel emboldened to enter the "Steel Carriages" controversy on account of what seems to me the consistent bias shown by the opponents of stock such as designed by Mr. Gresley for the L.N.E.R.

On January 31st, 1933, a train of this wood-on-steel-underframe stock was in collision at high speed. I have seen no authoritative statement of what the speed actually was, but the circumstances prove that it must have been at least in the neighbourhood of the usual "60 m.p.h." I have a collection of newspaper photographs which show that, apart from zigzag derailment, practically no damage was done. I can find only one pane of glass broken. Surely that is an excellent result.

I do not claim that it was obtained by the use of wooden bodies, but ascribe it to the type of vestibule and coupling employed. I imagine that if the stock had been all steel we should have not finished hearing about it yet.

On the other hand, we have what seems to me a remarkable case of "swallowing the camel" when we consider the use of gas in passenger stock. Your last correspondent says it is obsolete. Is it? Where else than on the very stock which is being adversely criticised? So far as I am aware, the L.N.E.R. are alone in having no gas whatever (*i.e.*, for cooking or lighting) as standard practice.

At the official inquiry into the Charfield smash, I think, Mr. Lemon, in answer to a question as to why gas was used for cooking, is reported to have said that electrical cooking was impossible or words to that effect. I write from memory, but the statement I read in your columns was so strikingly in contrast with the experience of the L.N.E.R. since pre-war days that I do not think I can be in error. Why the bias?

H. M. LACEY.

Leicester, January 21st.

THE VULNERABILITY OF ELECTRICAL POWER.

SIR,—It is fortunate that not many people hold the views expressed by Mr. S. P. Christie in the correspondence column of the current issue.

Statistics are, of course, often unreliable, and can with a certain amount of ingenuity be made to prove practically anything. At the same time, they have their value, and I would suggest to Mr. Christie that he continues to collect data of shut-downs throughout the country during the next six months or so. At the end of that period, however, instead of merely counting up the total and applying it in a purely *destructive* manner, why not produce a *constructive* result by, for instance, dividing the total man-hours of efficient supply into the man-hours of shut-down, and see what fraction of 1 per cent. the answer comes to?

I, personally, have every confidence in the efficiency of the supply given by the vast majority of electrical undertakings, and, judging by the recent figures of electrical apparatus and units sold, so have most other people. After ten years in an all-electric house, taking a supply from Croydon Corporation Electricity Department, so far as I know there has not been one shut-down during the whole period which has not been previously advised by post card, and in case Mr. Christie may wonder whether things have happened during the night of which I was not aware, may I say that a non-self-starting synchronous clock installed fourteen months ago has never been touched since, and is still going strong?

Purley, January 20th. JOHN G. BENTLEY.

SIXTY YEARS AGO.

IT is legitimate perhaps to see in the Society for the Promotion of Scientific Industry, formed in Manchester in 1874, a forerunner of the Department of Scientific and Industrial Research. In some respects, however, its intended objects were curiously parallel with those of the new Inventions Advisory Committee of the Institution of Mechanical Engineers. The President of the Society was Lord Derby. He occupied the chair at the opening meeting held on Friday, January 16th, 1874, in Manchester Town Hall, and addressed a large gathering of gentlemen connected with the manufactures and commerce of the district. In our issue of January 23rd we accorded the new Society a warm welcome. We recognised that Great Britain's industrial supremacy had been acquired largely by accident, namely, by the fact that this country had been comparatively peaceful, free, and well governed during a lengthy period, when other countries had been disturbed by wars and commotions. We had had a start of 150 years over other nations in the cultivation of the arts of peace, but the advantages of that start had now disappeared. The French, Belgians, Germans, and Americans possessed natural resources at least equal to our own, and were in a position to meet us on what had previously been our own ground, and to undersell us in our own markets. Grave apprehensions, only too well founded, were, we said, entertained that much of our trade might depart from us. The remedy was clear. As a nation we must foster and encourage the growth of scientific industry, for on scientific industry alone could we depend for a continuance of the unexampled prosperity which up till then we had enjoyed. It was precisely for that purpose that the new Society had been formed. Its objects included the stimulation of invention and the development of new processes and novel machinery, and, in general, to utilise the very large amount of scientific power latent in the nation. One means of achieving that result which the Society proposed to adopt was to hold, from time to time, exhibitions of improved machinery and processes. It hoped, too, to be the medium for the introduction of new ideas to representatives of all branches of industry, to test and scrutinise novel plans, to expedite the industrial application of those which were worthy, and to hasten the demise of those which were not. It proposed to offer premiums and rewards for improvements in industrial machinery, processes and raw materials. While we welcomed the formation of the Society, we realised that it would have many difficulties to encounter and obstacles to overcome. Its success would doubtlessly encourage the establishment of similar societies in other parts of the country. We deprecated rivalry in this subject, and expressed the hope that the Manchester Society would, before long, extend its scope to cover the whole of Great Britain. The Society actually held its first exhibition almost immediately after its formation. At that exhibition it concentrated its attention on appliances for the economical consumption of fuel. In succeeding issues we published accounts of the principal exhibits, but it would seem that the exhibition failed to reveal any striking novelties. Nearly all the articles shown, we reported, had already been described in our columns or were otherwise familiar to most of our readers.

BOOKS RECEIVED.

Examples of Steel Design under the New Code of Practice. By Oscar Faber, O.B.E., D.Sc., &c. London: Oxford University Press, Amen House, Warwick-square, E.C.4. Price 7s. 6d. net.

The "Practical Engineer" Electrical Pocket Book and Diary for 1934. Edited by Conrad Arnold, A.M.I.E.E. London: Oxford University Press, Amen House, Warwick-square, E.C.4. Price 2s. 6d. net.

Modern Road Emulsions. Edited by F. H. Garner, M.S.E., Ph.D., L. G. Gabriel, B.Sc., and H. J. Prentice. London: Carriers Publishing Company, Ltd., 68 and 69, Shoe-lane, E.C.4. Price 12s. 6d. net.

Modern Steelwork: A Review of Current Practice in the Employment of Structural Steelwork in Buildings and Bridges. London: The British Steelwork Association, Artillery House, S.W.1. Price 5s. net.

George Washington Bridge Across the Hudson River at New York, N.Y. Published by the American Society of Civil Engineers in collaboration with the Port of New York Authority. New York: Port of New York Authority, 111, Eighth-avenue, N.Y., U.S.A.

AN OVERSEA TRANSPORT UNIT.—There has now been issued by the Overseas Mechanical Transport Directing Committee a booklet containing reports of the performance of the first petrol-driven, 15-ton oversea transport unit in this country and in the Gold Coast. This unit consists of a tractor with eight wheels, carrying a load of 3 tons, and two trailers, each on two four-wheeled bogies, carrying 6 tons, a total load of 15 tons in all. The net transport cost, inclusive of interest at 5 per cent., depreciation on a five-year life, insurance tax, spares, maintenance, fuel at 2s. 3d. a gallon, tires, garage and supervision, has worked out at 5½d. a ton-mile. The average load carried during a nine months' test has been 8·6 tons, while the weekly mileage averaged 237. The Gold Coast Government purchased the unit after the Committee had learnt all the lessons possible from its operation over the poor class roads of the colony. A second unit of the same type, which we described in our issue of July 21st, 1933, is now undergoing tests in this country, and will shortly be shipped to Australia. It is driven by an oil engine.

Railway and Road Matters.

WE hear with regret that Mr. F. H. Frere, District Engineer, Derby South District, L.M.S. Railway Company, died at his home, "Coombe Crest," Belper-road, Derby, on January 16th.

THE London, Midland and Scottish locomotives, "The Princess Royal" and the "Princess Elizabeth," now work through between Euston and Glasgow. The distance is 401½ miles, and so nearly 9 miles longer than the King's Cross–Edinburgh run on the East Coast. Better working is secured as engines have not to be changed at Carlisle.

THE traffic receipts for the first two weeks of the New Year are very satisfactory. Each of the four grouped companies reports an increase, which includes even a slight improvement in the passenger traffic. The total increases at the end of the second week were:—Great Western, £43,000; L.M.S., £157,000; L.N.E., £123,000; Southern, £8000.

IT has recently been stated, but not in THE ENGINEER, that the London, Midland and Scottish Company was asking for tenders for a large number of "all-steel" passenger vehicles. The important modification has now been made in this statement that the new stock is to be of "the latest standard type, with steel underframes and steel-sheeted wooden bodies."

THE Board of Trade export returns for the month of December show that during the year 1933 there were shipped overseas locomotives, carriages and wagons, rails, and wheels, metal sleepers, fish-plates, and miscellaneous materials of the value of £734,428, £527,291, £484,837, and £838,490 respectively. The corresponding figures for 1932 were £366,878, £748,757, £389,995, and £831,394.

FOLLOWING the recent installation of twenty-eight plants for the softening of locomotive water at strategic points on the two main routes between London and Carlisle, the L.M.S. Railway Company has decided to erect twenty-two further installations, with an aggregate capacity of 372,000 gallons per hour, at various places in the Midlands, Lancashire, Yorkshire, North Wales, and the West of England.

THE new loop at Greenisland, on the Northern Counties section of the L.M.S. Railway, was officially opened for public traffic on Wednesday, January 17th. This new connection, which was last referred to on page 624 of our issue of June 23rd last, provides direct running between Belfast and the North and avoids the reversal of trains at Greenisland—which is on the Larne branch—which has been necessary ever since the line was opened on April 11th, 1848.

THE Ministry of Transport's Tramway Returns for the year 1932–33—a Stationery Office publication, price 2s. 6d.—show that the receipts fell from £23,519,010 in 1931–32 to £21,987,059, a decrease of 6·51 per cent.; but the expenditure dropped from £19,321,752 to £17,841,554, a decrease of 7·66 per cent. The decrease in net receipts was thus one of 1·23 per cent. The number of passenger journeys by trollybuses rose from 184 million to 221 millions, an increase of 19·90 per cent.

THE Netherlands State Railways have recently ordered forty streamlined oil-electric motor trains, and expect to put the first batch of sixteen into service on May 15th on the Amsterdam-Utrecht-Arnheim line. They are three-coach sets and were designed by Netherlands Railways engineers and are being built in Holland. They will weigh 75 tons and will be capable of speeds up to 87 miles (140 kloms.) an hour, though a speed beyond 62 miles (100 kiloms.) an hour will not be attempted in the initial service.

THE new creosoting depôt of the Great Western Company at Hayes, to which reference was made herein on March 17th last, and in an annual article on January 19th of this year, will have a creosoting shed 500ft. long, with a pit 93ft. long by 21ft wide and 9ft. deep, in which will be fixed two creosoting cylinders and working tanks, 90ft. long. Three new 5-ton steam travelling cranes have been provided and are now in use for conveying the clean sleepers from the drying stacks to the adzing and boring machines, preparatory to creosoting and chairing.

THE Southern Area of the London and North-Eastern Railway has established a useful new department in the way of signalling schools. An old sleeping car has been dismantled and provided with a bench 40ft. long, whereon is a model railway, together with examples of every type of fixed and block signalling. The school can thus be taken to the pupils instead of men spending time and increasing expense in travelling. That is of particular advantage in the eastern section, which is widely scattered. The apparatus has been designed and constructed under the supervision of Mr. F. Downes, the signal and telegraph engineer.

THE Coroner's inquest into the deaths, on December 19th, of the driver and fireman killed near Hellifield, when their train collided with a goods brake van which had escaped out of a loop line and run back, resulted in a verdict of "Accidental Death." It is now clear that the van escaped on to the down main line because the loop points had been opened to allow the oncoming goods train to enter. We have yet to learn how it was that the van ran back along the loop, as the guard said that the brake was screwed down when he left it to carry on with some shunting. We hear that it has not been found practicable to draw the locomotive up the embankment where it was derailed and it is being dismantled.

IN a paper read before the Illuminating Engineering Society on January 9th, Mr. A. Cunnington, assistant for lighting, heating and water to the chief engineer, Southern Railway, said that, despite their inefficiency, paraffin oil flares continued to be used on the railway. That was on account of their extreme simplicity, which ensured their functioning properly in the hands of the most unskilled. Paraffin flares provided a mean horizontal candle-power of 50 at a cost —with paraffin at 1d. a pint—of 1s. 2d. per 1000 candle hours. Easily the most efficient among portable lamps was the incandescent mantle type of paraffin lamp. That gave an average mean hemispherical candle-power of 100 at a cost of 2d. per 1000 candle hours.

Notes and Memoranda.

ACCORDING to a recent paper by Mr. E. R. L. FitzPayne, the efficiency of the petrol engine, with a compression ratio of 5 to 1, is 47 per cent., and that of the compression ignition engine, with a ratio of 12 to 1, is 55 per cent. As the efficiency of a petrol engine working at a compression ratio of 12 to 1 would be 63 per cent., the popularity of the compression ignition engine is not due to thermodynamic superiority, and if the fuels were bought on the same basis the only advantage in employing this type would be reduction of fire risk.

WRITING to the *Machinist*, Mr. W. E. Warner says that rusting oi iron and steel can be prevented by the following treatment:—First make up a mixture by dissolving 1 oz. of camphor in 1 lb. of melted lard. Skim off any scum which forms and add finely powdered blacklead until the mixture has an iron colour. Allow it to cool and then smear the parts. Leave on for twenty-four hours and rub the parts clean with a soft cloth. This will fill the pores and prevent rusting. The parts will be dull but not greasy to the touch. This treatment is excellent for small tools and machine parts on which grease is inadvisable.

AT the request of the Building Research Board, experiments are being carried out by the National Physical Laboratory, Teddington, with the object of obtaining data which will enable the effect of wind pressure on buildings and other structures to be placed on a scientific basis. One stage of this research has been completed, and the results are embodied in a report by A. Bailey, M.Sc., A.M. Inst. C.E., just published by the Institution of Civil Engineers. Experiments have been made both on an actual building and on a model structure in a wind tunnel. The experiments show that the negative pressure produced on the leeward side of a building by a high wind is generally much greater than had been suspected.

IN the course of a lecture before the Junior Institution of Engineers, Mr. H. J. N. Riddle described the Autoflex system of traffic control. In it the vehicle detectors, commonly called "mats" or "pads," are of original construction, avoiding an electrical contact or connection in the roadway. The "mat" consists entirely of a rubber moulding set in a non-fracturable metal trough, the moulding having air channels running through its length. The passage of vehicles over the mat displaces a certain amount of air from these channels, this displaced air operating a pneumatic contact device, connected to the mat by metal tubes, and placed on a convenient spot in the pavement adjacent to the mat. The absence of metal embedded in the mat body and of electrical connections subjected to the action of traffic and weather, also the ease with which the pneumatic contact action may be watched with the installation working in the normal way, are claimed as some of the advantages peculiar to this system.

A NEW report issued by the Department of Scientific and Industrial Research—Building Research Technical Paper No. 15, "Temperature Rise in Hydrating Concrete"—deals with the rise in temperature in concrete in the process of setting and hardening caused by the chemical reactions between water and cement. In large masses of concrete the rises in temperature may be considerable, and this may not only affect the properties of the material itself, but may influence the distribution and intensity of stresses throughout the mass. The report contains particulars of observations of temperature rises made on some fifty important concrete structures in various parts of the world. These observations collected from practical experience should provide useful guidance for similar operations in the future. They show generally that with modern cements there is a tendency to attain higher maximum temperatures, and to attain these temperatures in a much shorter time, than was the case with cements formerly used. The report may be obtained from H.M. Stationery Office, price 1s. 3d. net.

THE United States Line's "Manhattan" has, according to *Shipbuilding and Shipping Record*, been fitted with a fog camera, which automatically takes a photograph, by the use of infra-red rays, of objects which, during fog, are invisible to the human eye. The instrument is the invention of an American master mariner, Flavel M. Williams, New York, and records on a specially treated infra-red film strip fog-hidden objects ahead of a ship, and also develops and "fixes" the negatives in 30 seconds. By pressing a button, which illuminates the negative, the navigator may view the picture he has taken 30 seconds after opening the lens shutter. In this way the camera "staring" ahead into the fog makes a visual record, at 32-second intervals, of the ship's progress through fog, and may record other ships, rocks, or the shore line, which the navigator himself cannot see. When haze alone exists the range of the camera is practically unlimited, but infra-red rays cannot penetrate water or solid matter, and consequently its effectiveness is reduced in fogs of the water-vapour type, and it cannot, as yet, be used at night, although considerable progress is being made in experiments to eliminate this disadvantage.

THE mining and prospecting activities of Canada in 1933 have proved a boon, not only to the mining centres of Abitibi and Témiscamingue counties, but also to the settlers and to the farming communities to whom the mining camps provided keen markets for all they could produce. The development of Western Quebec in the last ten years is an outstanding example of the colonising influence of the mining industry in regions where the soil is fit for agriculture. The country was opened to the farming settlers in 1911 on completion of the National Transcontinental Railway, yet ten years ago the population of the district was practically limited to a narrow strip of two to four miles on each side of the railway. But following the discoveries of gold and copper along a belt which somewhat parallels the railway line 40 miles to the south, there are now numerous centres of population along this mineral zone. The principal one of these centres is constituted by the twin towns of Noranda and Rouyn, with a combined population of 6000, served by two railway lines, 50 miles south of the National Transcontinental line, at a spot which a very few years ago was only accessible by canoes and portage trails, frequented only by seasonal trappers and prospectors.

Miscellanea.

THE new North Ireland Regional radio station, with a power of 150 kW, is to be erected at Blaris, Lisburn.

AN aluminium factory is to be built at Mansbo, Sweden, with a productive capacity of about 1800 tons, sufficient to supply the whole of Sweden's need in aluminium wares.

THE Postmaster-General states that the revenue of the Post Office telephone department was £24,440,000 (subject to audit) in the year 1932–33, the number of telephones being 2,137,100.

AN all-welded vertical-lift bridge of the Vierendeel type, with a 69ft. span, has recently been completed at the South Manchuria Railway Company's wharf at Kawasaki Harbour.

THE dome of the Winnipeg railway station of the Canadian National Railways has been covered with 10,000 square feet of copper capping. The copper used weighs 16 oz. to the square foot, bringing the total weight of the new cap to nearly 5 tons. It is considered that this copper covering will last for fifty years.

THE total developed water power in countries having an installed capacity in excess of 100,000 kW is given in a table which has been prepared by the American Committee of the World Power Conference. The total is estimated at 39,257,000 kW, and the list is headed by the U.S.A. with 11,800,000 kW, Great Britain coming seventeenth on the list with 228,000 kW.

A ROYAL Commission in Holland has made some sweeping recommendations with regard to the Dutch Navy, among them being that of the three Dutch naval bases at Amsterdam, Flushing, and Helder, only the latter should be retained. It also recommends reducing the professional navy by half and the dissolution of the corps of marines, and that all obsolete ships and war material should be broken up.

FROM base to crest, the Hoover, now called the Boulder, Dam, now under construction in America, will rise 730ft. It will be 660ft. thick at the base, 45ft. thick and about 1180ft. long at the crest; 3¼ million cubic yards of concrete will be used on this structure; 130,000 cubic yards in the power-house, 100,000 cubic yards in the four intake towers, and 45,000 cubic yards in penstock tunnels. Several articles on the construction of the dam have appeared in THE ENGINEER.

IT is stated that radio will be used to aid in the construction of the San Francisco–Oakland Bay bridge. Engineers have decided to use it as a means of communication with workers on isolated bridge piers far out in the bay and on boats going across the bay. The wireless telephone will operate on a 4 m. to 6 m. wave length, and the engineers will be able to speak from either shore with men at work on the piers, or can intercept men in boats on their way to the job.

AN increase of 33 per cent. in oil production is laid down in the Soviet production programme for 1934, the total figure being fixed at 30,600,000 tons, says the *Chemical Trades Journal*. Production of benzine is to be increased by 8·8 per cent., and that of paraffin by 24·1 per cent. New oilfields at Mikoyen and Azizbekov were opened up last year, and have already produced 2,000,000 tons of oil. Prospecting is being actively continued with a view to developing further sources of supply.

DURING the recent visit of the Duke of Gloucester to Manchester, he visited the Park Works of Mather and Platt Ltd., and there witnessed a demonstration of the Mulsifyre system of extinguishing oil fires with foam. A tank, 24 feet square, had been constructed to represent a ship's boiler-room floor. It was flooded with 3000 gallons of oil, which was ignited. When the flames had risen to a height of 30ft. or so, the Duke opened the valve supplying the foam jets, and the fire was put out in two seconds, with the consumption of less than 40 gallons of water.

MARINE engineers will learn with regret of the death of Mr. James Andrews, of Andrews and Cameron, Kirkintilloch, which took place at his home in Lenzie, near Glasgow, last week-end. Among Mr. Andrews' best known invention was a balanced slide valve, which has been widely used in recent marine reciprocating engine practice. Mr. Andrews, who was a native of Kilmarnock, set up business in Glasgow in 1904 with Mr. D. Cameron, and two years later the firm moved to Kirkintilloch, its present headquarters. Mr. Andrews was in his seventy-first year

THE annual administration report on Selangor, Federated Malay States, records that during 1932 the two-pinned, reinforced concrete arch bridge constructed by the Public Works Department at Kuala Lumpur, to replace the old High-street and Kampong Attap bridges, and commenced in May, 1931, was successfully completed at a cost of 111,074 dollars. This bridge, which is the largest of its kind in Malaya, has a clear span between arch springings of 153ft.; it carries a 40ft. carriageway and two 7ft. 6in. sidewalks, with provision for pipe lines and electric cables.

AT the annual general meeting of the National Federation of Bridge and Structural Engineers, held in London last week, Mr. E. A. Willson, of Archibald D. Dawnay and Sons, Ltd., was re-elected chairman for the coming year, and Mr. W. T. Thornhill, of Rubery, Owen and Co., vice-chairman. The Executive Committee includes Mr. H. Cunningham, of Sir Wm. Arrol and Co., Ltd.; Mr. T. R. Miller, of the Motherwell Bridge and Engineering Company, Ltd.; Mr. A. Robson, of the Fairfield Shipbuilding and Engineering Company, Ltd., and Mr. Grahame H. Thomson, of P. and W. MacLellan, Ltd.

THE most recent case of bell-repairing by welding is the reconditioning of four very beautiful old inscribed bells from the Church of St. Mary, Woodbridge, Suffolk. They weighed 26½ cwt., 17½ cwt., 12½ cwt., and 9½ cwt. respectively, and date from 1799, when they were cast by Thomas Osborn, of Downham Market. In each case there were extensive cracks in the crown caused by the rusting and consequent expansion of the iron clapper staple. After repairs the bells were sent to Messrs. Gillett and Johnston, of Croydon, for any re-tuning that might be necessary, but it was found that none was needed. The work was carried out by Barimar, Ltd.

HYDRAULIC JUMPS IN CHERRY CREEK, DENVER, COLORADO

(*For description see page* 91.)

UPSTREAM SIDE OF HYDRAULIC JUMP AT MAXIMUM STAGE OF FLOOD, AUGUST 3, 1933

DOWNSTREAM VIEW OF PRIMARY AND SECONDARY STANDING WAVES

DOWNSTREAM SIDE OF PRIMARY STANDING WAVE DURING MAXIMUM STAGE

The Engineer

JANUARY 26, 1934.

VOL. CLVII. No. 4072

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NOTICES TO READERS.

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INVENTIONS AND INVENTORS.

IT is stated in the Royal Charter of the Institution of Mechanical Engineers that amongst "The objects and purposes for which the Institution is hereby constituted" is "To encourage invention and research in matters connected with Mechanical Engineering and with this object to make grants of money or books or otherwise to assist such invention and research." In the January *Journal* (1934) of the Institution the following passage appears, under the heading Inventions Advisory Committee:—"The Council have appointed a Standing Committee with this title to carry out the first object of the Institution, as stated in Clause 7A of the Royal Charter, so far as that applies to inventions. It is intended that the Committee should consider applications for advice and assistance from members in respect of their mechanical engineering inventions, and it is proposed to award prizes and certificates periodically for meritorious devices. The Council hope that advantage will be taken of the facilities offered, especially by the younger members, amongst whom it is particularly desired to encourage the inventive faculty." In the old Articles of Association of the Institution it was said that it was established "(A) To promote the science and practice of Mechanical Engineering and all branches of mechanical construction, and to give an impulse to inventions likely to be useful to the Members of the Institution and to the community at large." If there is no substantial difference between giving an "impulse to inventions" and "encouraging invention," then there is no more reason why the Institution should have established an Inventions Advisory Committee at this time rather than at any other in its long history. If there is a difference, if the words of the charter do in fact mean that direct encouragement of inventions and inventors is amongst the duties of the Institution, then we fear that the charter—*sui generis*—will place the Institution in a difficult and embarrassing situation. We may, however, express our own opinion, for what satisfaction it may be to the Institution, that the words in the Charter mean no more than those in the Articles and that within the meaning of the term invention is encouraged by all the activities of the Institution. Hence, if our view is right, there was no obligation for the Institution to set up the new Committee, and that it has done so may be justly regarded as but one more voluntary effort on its part to be of direct benefit and use to its members.

On Friday last a general meeting was held at the Institution to discuss this new activity. It opened with a symposium of four papers, which was followed by a discussion that was perhaps more entertaining than useful. At any rate, it did little to define the work of the new Advisory Committee and can have given the members of that Committee but little guidance as to the lines they should take. In fact, it followed the usual course of discussion, oral or written, on inventions. We had the familiar complaints about the Patent Laws, the familiar examples of England's neglect of her inventors, and the familiar plaint of the cost of developing new inventions. Two speakers, both manufacturers, were, we were glad to observe, bold enough to damp the expectations of the outside inventor. Both of them, Sir Ernest Petter and Mr. Benton, stressed the fact that the odds were weighted against any inventor who was not actually engaged in the industry with which his invention was concerned. These odds have always existed, but they become heavier every day as the development of machines and processes increases. Now and then, as Mr. Dickinson showed in his paper, men entirely outside the field have made profitable inventions in mechanical engineering. But, generally speaking, it may be said that an inner knowledge, not alone of particular machines, but of the means by which those machines are produced and the conditions under which they are used is essential. An admirable invention might be ruthlessly turned down—to put the action euphemistically—if it would involve costly changes in equipment, or the employment of a material which it was difficult to obtain, or might cause labour and economic troubles in a factory. The Committee may be beneficent if it can convince inventors that manufacturers generally know more about their business than the outside inventor, and that their rejection of inventions is not always dictated by crass folly and prejudice. Another author, Mr. Gledhill, did a useful thing in explaining that the profits ordinarily made by invention are far smaller than the rare and wonderful prizes occasionally secured by some lucky hit. But such matters, and Sir William Jarratt's wise advice about protection, deal rather with the general subject of invention and inventors than with the nature of the encouragement that can be given by an advisory committee, and it was on that point that we hoped for some elucidation.

The establishment of that Committee is characteristic of the age in which we live—an age which might be called the Escalator Age—an age when machinery carries people upstairs to save them the trouble of making an exertion themselves, an age when self-help is being replaced by Committee help. The Institution is no doubt justified in living in the spirit of the time and endeavouring to replace the encouragement of invention which has hitherto been given by its usual activities by something more definite. But, frankly, we shall be surprised if the Advisory Committee survives more than a year or two the difficulties which it will encounter. It is not the first advisory committee. Under the title "Sixty Years Ago" we report, on another page, the establishment in 1874 of a body with precisely the same intentions as those of the new Advisory Committee. We do not know how long that body existed but, to the best of our belief, it has long since been defunct. During the war a similar body was set up under the Ministry of Munitions. Its duty was to examine all inventions submitted to it and separate the sheep from the goats. Thousands passed under its scrutiny, but it is on record that, on a high estimate, not more than 10 per cent. were worth a second glance, and we have been told that perhaps not one-tenth of one per cent. was worth pursuing. Of course, many useful inventions were made during the war years; but they were made by the people who knew; the people engaged in the business; the people who were aware of what could and what could not be done profitably. Since it is certain that manufacturers will not bring their inventions before the Committee, it is manifest—indeed, that, we take it, is the intention—that it is the outside inventor who is to be encouraged "by grants of money or books," by "prizes or certificates." But if the history of the Ministry of Munitions Committee repeats itself—as it surely will—the Committee will find itself mainly engaged in the thankless task of telling inventors that their ideas are valueless or that their mechanisms have no chance of adoption. The Committee may indeed give sound advice, and it is conceivable that now and then, once in a thousand times, it may bring an inventor and a manufacturer together. But there are people whose business it is to do these things, and they will hardly look with complacency upon its activities. These are but one or two of the difficulties which, we foresee, lie in front of a Committee which with fine intention the Institution has set up. We should be glad to see it a success. Particularly we should rejoice if by its means or through its good offices more British inventions were adopted and less reliance was placed upon licences from foreign inventors. If it can do no more than induce British manufacturers to adopt as their slogan "British Inventions First," it will fully justify its appointment.

Locomotive Performances.

WE published in our issue of November 17th an article from an address delivered to the New York Railway Club by Mr. William C. Dickerman, President of the American Locomotive Company, who took for his subject "Modern Trends in Railway Motive Power." Naturally, the lecturer approached his subject from the American viewpoint, and so far as the references made concerned the powers developed by modern steam locomotives, the data given are entirely limited to practice in the United States, for elsewhere conditions do not call for such very large engines. In other respects, however, we suppose locomotive development elsewhere has proceeded much along the lines indicated by Mr. Dickerman, and that the remarks made on the increase in steam pressure, the use of high steam temperatures, and the effect of these on the consumption of fuel and water probably apply with equal force here.

Not the least interesting of the observations made were those referring to the actual thermal efficiency attained by the steam locomotive. Thermal efficiency is not the only measure of locomotive performance. It is recognised that high thermal efficiency, meaning a low consumption of fuel per unit of work done on the draw-bar, should be one of the designer's major considerations; but if maximum performance in this respect is attained by added complication with increased maintenance costs, any claims made for superiority of performance would be confined to the test observers only. The truth is that in measuring locomotive performance we cannot confine ourselves to one standard alone. There are two meanings for the word "efficiency." We may have on the one hand an economical engine judged by fuel consumption, or we may have one less efficient, but which is capable of making a greater mileage in a given time at a less cost in upkeep. Every one recognises now that thermal economy and efficiency are far from being synonymous terms. Maximum efficiency is governed by the successful combination of a low consumption not of fuel alone, but of other consumable requirements, including upkeep charges, and a maximum output in revenue-ton-miles over any given time period. It is the realisation of this that is attracting the attention of locomotive engineers. Modern steam locomotives are efficient, not altogether because for a given output they use so much less fuel than their predecessors, but because they can do so much more work in a given time: the "service ability," as Mr. Dickerman calls it, is so much greater. We have always maintained that there are—or, shall we say, were—considerable opportunities for improving the economy of steam locomotive power, and we may perhaps refer to our impression of May 2nd, 1924, where we advocated an increase in the length of individual locomotive runs as a means of securing more economical operation. We instanced on that occasion, as showing the practicability of such working, the experiment carried out by F. W. Webb, with his engine "Greater Britain," which ran each day for a week the double journey between Euston and Carlisle, thus accomplishing in round figures 600 train miles each twenty-four hours. It will be of interest to remark that the L.M.S. engines of the "Royal Scot" class, and also the new "Pacific," "The Princess Royal," and her sister, as part of their regular duties make exactly the same daily mileage, for when working the "up" "Royal Scot" express from Carlisle arriving at Euston at 5.45 p.m. the return journey is made the same evening with the Perth express, due to leave London at 11 p.m. The principal differences are found in the weights of the trains handled, for whereas the engine "Greater Britain" dealt with loads averaging some 160 tons, the modern locomotives have to

haul trains of something like 450 to 500 tons behind the tenders at appreciably higher mean speeds, and, moreover, the "up" journey is made without a booked stop. Thus the net ton-miles per hour are now more than trebled.

In writing thus, we have no desire in any measure to decry efforts made to improve the actual thermal performance of the steam locomotive. But that is not easy, not, indeed, because efficiencies as such rule high, but rather because the complexities of the problem are great, so many factors having to be considered; further, when any given improvement is made, it is attainable under one set of conditions, and may be wholly, or, at any rate, in part, largely obliterated when traffic requirements call for work of a different nature. Neither do we wish in any measure to cloak the issue, for we are bound to admit that thermally we cannot say much for the steam locomotive. Nevertheless, as an economic means of motive power, it still seems difficult to do better, and the fact that three of our great railway systems have recently between them placed orders for the construction of 400 steam locomotives, embracing types for all classes of service, would appear to support this contention.

The Encouragement of Invention.

INSTITUTION OF MECHANICAL ENGINEERS.

THE Council of the Institution of Mechanical Engineers recently appointed a standing committee, the Inventions Advisory Committee, and charged it with the duty of implementing Clause 7A of the Royal Charter, so far as that clause applies to invention. That clause states that among the objects and purposes for which the Institution is constituted is the encouragement of invention and research in matters connected with mechanical engineering, and with that object to make grants of money or books, or otherwise to assist such invention and research. It is intended that the Committee should consider applications for advice and assistance from members in respect of their mechanical engineering inventions, and it is proposed to award prizes and certificates periodically for meritorious inventions. It is hoped that the establishment of the Committee will encourage the inventive faculty, particularly among the younger members.

On Friday of last week an extra general meeting of the Institution was held in London, at which a symposium of papers dealing with invention, and arranged by the new Committee, was presented and discussed. The papers were four in number, their titles and authors being as follows:—"The Evolution of Invention," by Mr. H. W. Dickinson; "The Inventor," by Dr. H. S. Hatfield; "Provisional Patent Protection and Patent Claims," by Sir William S. Jarrett; and "The Development and Exploitation of Inventions," by Mr. A. H. Gledhill. We reprint in full Mr. Dickinson's paper elsewhere in this issue.

Sir Ernest Petter, opening the discussion, said that as head of a large manufacturing concern he had many inventions brought before him, but very seldom were they of any practical value. He believed that what Mr. Dickinson had called primary inventions must, with the passage of time, become fewer and fewer, and that the development of secondary inventions constituted the real factor of service to the country. Secondary inventions were nearly always produced by men working in close contact with the subjects to which the inventions related. They were evolved in the drawing-office or the research or experimental department, and were very rarely produced by people outside the particular field of industry to which they related. If anyone was working on an invention in some field other than his own, his advice to such a one was to give up the work. Inventors nearly always had an exaggerated opinion of the financial value of their ideas. If the invention turned out to be a failure, they said nothing about it, but if it was a success they nearly always said that they had not received their fair share of the profit.

Mr. E. W. Moss thought that the appointment of the Committee would commend itself to all members of the Institution. Among the members were experts in every branch of mechanical engineering, and it would be of very great value to young inventors to have their ideas submitted to and criticised by those with a thorough knowledge of the field to which their inventions related. The question of rewards to inventors was one of the most difficult which the subject presented. If the Committee could make any useful suggestions as to the manner in which the interests of the employee-inventor could be dealt with in a manner fair to all, it would render good service. He thought that Mr. Gledhill's suggestion that some portion of the Patent Office's annual surplus should be devoted to the encouragement of invention, a very good one, but he had very grave doubts whether it would be adopted by the Government.

Dr. A. P. Thurston argued that the present state of the law had much to do with the difficulties in which inventors frequently found themselves. He reminded the meeting that Fleming had made no profit from the invention of the thermionic valve, and that the late Sir Charles Parsons derived no financial gain from the invention of the steam turbine during the sixteen years' life of his earlier patents, and did not reap his reward until those patents had been granted an extension by a special Act of Parliament. Referring to what Mr. Dickinson had called the hit-and-miss method of making an invention, he said that the most striking instance of that method was perhaps to be found in the history of the discovery of stainless steel. That material, he said, owed its discovery to a young apprentice who was struck by the fact that a particular piece of steel, thrown out on to a scrap heap, had not rusted like other specimens in the same heap. We should be glad to have specific confirmation, or otherwise, of that story.

Mr. Kilburn Scott entertained the meeting by the vehemence of his denunciation of the whole patent system, and its iniquities. Of the various points which he sought to make, perhaps the most striking was covered by the scorn which he poured upon the fact that by the will of Parliament sixteen years' protection was granted to one who invented a steam turbine, and equally to one who introduced an improvement in hair pins. He also spoke strongly against the high charges for patent protection in this country. The stamp fees for sixteen years' protection in Great Britain amounted to £120. In the United States nineteen years' protection could be secured for a total fee of £20. Those figures, he said, should be studied in conjunction with the fact that the population of the British Isles was 48 million and was increasing at the rate of 2¼ per cent., whereas the population of the United States amounted to 120 millions, and was increasing at the rate of 14 per cent. The British fees covered protection only within the British Isles. If protection were desired throughout the British Empire, the total fees for the sixteen years' period would amount to over £500, and in every Dominion and Crown Colony there would be a patent attorney to whom additional fees would have to be paid.

Mr. A. Page agreed with the view that the Patent Laws as they now stood assisted the manufacturer more than the inventor. He thought that the imposition of a clause in an employee's contract assigning to the employer interest in any invention which he might produce during the term of his engagement should be made illegal. If some such clause were desired, it should stipulate that the employee would receive an immediate small monetary reward, followed by a royalty on the working of the patent. Mr. Page also suggested that a very useful purpose would be served if physical properties and phenomena were tabulated in conjunction with the uses to which they had been put by mankind. Many properties and phenomena were not yet used or fully used. The suggested tabulation would be of very great service to inventors, and would encourage them to exploit natural facts to which no or little attention had at present been given.

Mr. W. A. Benton contended that insufficient attention was paid to the man with original ideas, who clearly saw how a thing could be done. He was the real inventor. For one such man, there were ten thousand who were merely improvers and adapters. John Wyatt, who invented the weigh-bridge in 1739–41, and who laid the foundations of all subsequent work in that direction, was a real inventor. He was, however, imprisoned for debt, and died in poverty. The majority of patented inventions were, he continued, useless, not because they were impracticable, but because they displayed no knowledge of the present state of the craft to which they related. There were no doubt instances in which, as Mr. Dickinson had said, outsiders with minds not overburdened by details, had succeeded in making notable inventions in fields other than their own, but it was an essential requirement for success in the exploitation of such inventions that their originators should get into touch with and understand the craft.

Mr. A. F. Ravenshear said that in a recent British Association Presidential Address it had been argued that the world must cease to invent or submit to a permanent decrease of employment. He did not believe the implications contained in that statement. Secondary invention resulted in cheapening existing products, but primary invention broke new ground. What the country needed was more invention of the right kind.

Mr. William Taylor, as Chairman of the new Advisory Committee, was called upon to conclude the discussion. He thought it was clear that the Committee would find plenty to do. It would, however, prepare its plans as it went along, and as circumstances arose. Dealing with the question of injustice to employees, in connection with the assignment of patents, he said that in his own works a scheme was in force whereby any suggestion for an improvement in the firm's products was put into writing and came straight to himself as head of the business, without the possibility of its being intercepted. Some such arrangement might be embodied in a model code to govern the relationship of employee and employer as regarded patents. It was undoubtedly true that unsatisfactory situations could readily arise because of failure to prepare agreements concerning employees' inventions and the rewards to be made for them. It should not be assumed, he continued, that all inventions were patented. He himself had patented about two hundred inventions, and had produced over two hundred more which he had not patented. Whitworth, it might be noted, did not patent the three-surface method of originating plane surfaces. There were many such unpatented inventions, and he thought it might be possible for the Committee to arrange exhibitions of them. From his own experience, he could agree with Sir Ernest Petter's statement that an inventor very rarely made any profit from an invention not connected with his own business. Speaking of the work of the new Committee, he said that it might serve as a means of introducing members with inventions which they could not work to other members in a position to work them.

Col. A. E. Davidson, who occupied the chair at the meeting, has sent us the following remarks, which he had intended to make had time permitted:—

While a good deal has been said from the points of view of the inventor or patentee, the patent agent, and the employer under whom the inventor is working, nothing has been said by anyone whose interests are primarily those of the user. In this capacity one is frequently asked to look at and take into use some new invention. It is thought that the biggest hurdle in the way of the inventor is not the granting of the patent, but in getting the invention turned into commercial use. For example, while the invention may be a considerable technical improvement on what has gone before, it may fail under the stress of use either on account of prohibitive cost of manufacture, complication, or expense in service. The user therefore will require to know, before he takes up the invention, how it is going to affect the capital cost and the working cost of the product, this last covering the maintenance costs on which it may not be possible to obtain results without lengthy trial. This frequently costly experience may have to be shouldered by an intermediary other than the inventor or the user.

Thus, speaking as the user rather than either the inventor or the producer, it is easy to see why some heat has been evidenced in the course of the discussion as to the relative claims to cash or credit as between the man who produces the new idea and the man who produces the article in a saleable form. Sometimes the idea is everything and sometimes the production. It may require an impartial judge to settle the relative merits as between the two conflicting views.

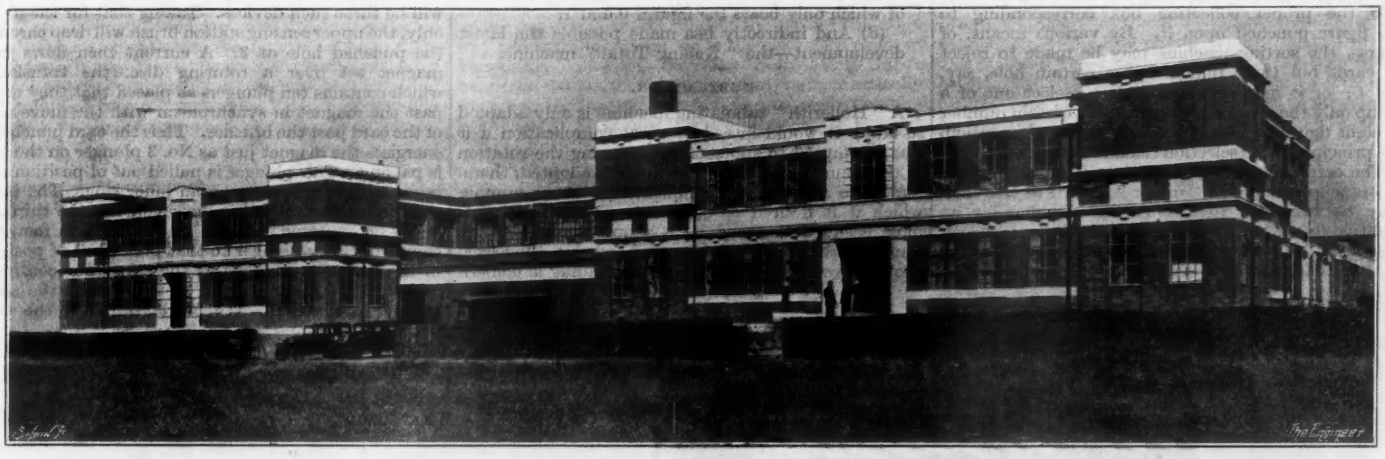
It is considered that there is a good deal of luck in the making of an invention. It may be many years ahead of its time and incapable of producing wealth until a much later date. This may be due to the lack of inventions produced later which alone permit production to proceed. A good example of this can be seen in the Rotunda at Woolwich, where there are housed examples of rifles and guns illustrating the history of that art. There is on exhibit a gun with an interrupted screw mechanism dating back to 1680, and a rifled barrel dated 1547. The breech-loading gun only came into general use towards the end of the last century.

The subject of inventions and patents was dealt with in some detail in the presidential addresses of Professor Hele-Shaw and Sir John Dewrance in 1922 and 1923 respectively. The latter indicated the vast number of patents taken out each year, the large sums of money paid for protection, and the small percentage that actually paid for their keep. Sir John, in fact, stated that only one mechanical patent in ten thousand was worth exploiting.

In view of the small number of these patents that are real Derby winners, and speaking as one who (partly from being employed in the service of the Crown) has never taken out a patent, it is for consideration whether, except for pride of parentage, the cost of taking out a patent is always worth while. It is suggested to the new Committee that it might be worth while setting up some means of giving publicity to new ideas and inventions which would save the originators the costs referred to above; and, on the other hand, would prevent these ideas from being used against them by rivals should these ideas later on be required in ways not thought of by the original inventor.

THE consumption of platinum throughout the world in 1933 is estimated at 175,000 oz., against 75,000 oz. in 1932.

THE WORKS OF THE BRITISH TABULATING MACHINE COMPANY, LTD., LETCHWORTH



The Hollerith Tabulator.

AT various times, separated by intervals several years in length, we have recorded the gradual improvements made in "Hollerith" tabulating machinery, as supplied by the British Tabulating Machine Company, Ltd., of Letchworth, Herts. In this article, besides describing some of the more recent developments, we also have the pleasure of putting it on record that the products of the company are now almost entirely made in this country. We say "almost," because there still remains one part imported from abroad, not, however, because it cannot be manufactured in this country, but for the reason that experiments are taking place with the object of improving that part, and it has not been regarded as worth while to lay down plant for its manufacture until its design is finally settled. When the company transferred its works from London to Letchworth, it was with the intention of eventually manufacturing the whole of its products, but until the last two years a considerable proportion of the parts were imported and machines assembled in the factory. Consequently, the final decision to start the actual production of the parts in this country has resulted in a very considerable expansion of the works. An increasing number of yearly orders has had a similar effect. Some conception of the change that has taken place since the war can be gathered from Table I., which, besides showing the floor area of the factory, also indicates the number of men employed, and the costs of raw materials, of machine tools, &c., and of jigs and tools either manufactured in the works or purchased from other firms.

During 1934 it is intended to install equipment to the value of a further £2000 for the manufacture of jigs and tools.

Our original intention on our recent visit to Letchworth was solely to write a description of the works. On being introduced to the machines made by the company, however, we found that since we last described a tabulator, very important and interesting developments have occurred. Consequently, we determined that some description of the new powers of the machines ought to be attempted. Nor, in fact, will some mention of the machines themselves be a hindrance to a description of the works in which they are produced, for only a good conception of the requirements of the manufactured article can really explain why this or that particular lay-out was adopted, or why it is essential to use one particular class of machine for one definite purpose. Our intention, therefore, before proceeding to a description of this very interesting works, is to examine in some detail the various new devices that are now incorporated in tabulating machinery.

TABLE I.

Year.	*Personnel* at end of year.	Raw materials purchased.	Jigs and tools. Purchased.	Jigs and tools. Manufactu'd.	Machine tools purchased.	Factory areas.
		£	£	£	£	Sq. ft.
1920	60 appx.	1,040	—	—	250	20,240
1925	80	1,040	430	230	3,200	25,960
1930	160	3,260	540	820	1,030	39,116
1931	182	2,720	400	840	600	—
1932	255	5,080	1,020	4,380	7,350	53,806
1933	364	6,790	3,000	9,200	11,250	65,823

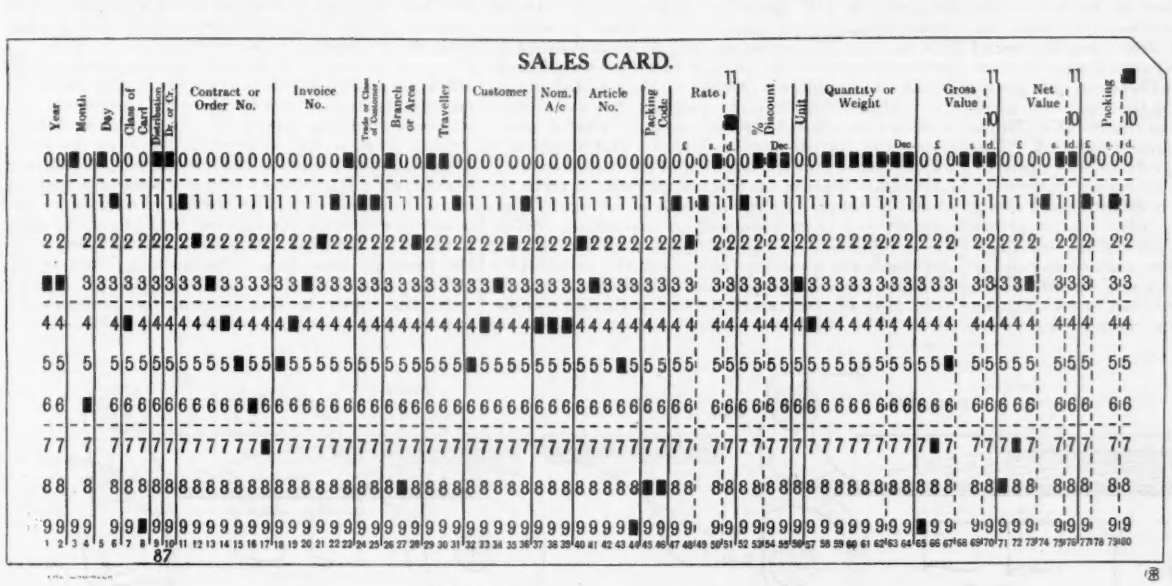


FIG. 1—TYPICAL 80 COLUMN CARD

PRINCIPLES OF OPERATION.

The cards for use with the "Hollerith" tabulating machine are probably familiar to the majority of our readers. By a recent development it has been found possible, as may be seen from the engraving, Fig. 1, to place eighty columns of figures on the card instead of forty-five; and sixty instead of thirty-four on the short card as heretofore. It will be remembered that information is arranged on the card by punching holes in it in the various columns. Originally, these holes were round, but with the new eighty-column cards they take the form of slots. Each card is divided by vertical lines into a number of "fields," which may be of two kinds—selective or additive. For instance, the fields headed "Contract or Order No., Invoice No., Traveller, Customer," &c., are selective, while fields such as those headed "Quantity or Weight, Gross Value, Net Value," are additive. The information recorded on the card is collected by the tabulating machine by means of a row of brushes arranged in line at a sensing station through which the cards pass one after the other, bottom first. The brushes penetrate the punched holes in the card and make electric contacts with a "roll contact" behind. Thereby a printing mechanism is energised to print the information derived from the card; or, in the case of additive fields, to cause counting wheels bearing the digits from 0 to 9 on their peripheries to rotate. There is a bank of such counting wheels for each additive field on the card. For the sake of brevity we must assume the reader to be familiar with the mechanism by which the contact of the brush through the hole in the card is made to rotate the corresponding counting wheel or energise the corresponding printing unit. We described it fully in a series of articles appearing in our issues of January 27th, February 10th, February 24th, and March 17th, in 1911, and except in detail design it remains much the same to-day. It will be recalled, however, that before the cards are taken to the tabulating machine, it is usually necessary to "sort" them. Thus, in the case of the card under discussion, it might be required to find the total net value of the goods sold in each of several branches or areas, and the corresponding values for each traveller in each of these areas. Under such conditions it is necessary, firstly, to sort the group of cards so that all those belonging to each branch are together, and to re-sort each of these sub-groups so that all the cards recording the activities of each separate traveller are together and in order. Since we last described a sorting machine, a very considerable simplification has been made. A typical machine is illustrated in Fig. 2, and the mode of selection in the diagram, Fig. 3. When arranging cards in numerical order, they are first sorted on the units column of the "selective" field concerned. The ten boxes, corresponding to the digits 0 to 9, are then emptied in order and the cards are re-sorted, this time on the tens column, the process being repeated across the whole width of the field concerned. It will be seen, therefore, that for any one "sort" only one column of the field is concerned, and a selection must be made between the cards punched with the ten different digits. In actual fact, the machine illustrated has thirteen collecting boxes. One is for "rejects"—cards not punched at all in the column concerned—and the two others are for the X and Y positions, which will be further mentioned later, and need not concern us now. The cards are stacked, face downwards, on the table of the machine, and fed through a sensing station of which only one brush is energised. As the card feeds through beneath the brush its leading edge comes into contact with a number of spring blades, the ends of which are turned up so that the card may push its way beneath, as shown in the left-hand diagram in Fig. 3. At a certain moment the energised brush drops through the punched hole in the card, and makes a contact, with the result that a magnet is energised and pulls down a plate which is supporting the spring blades. Since, however, the blades and the plate are quite narrow,

the card remains supported in its former position and holds up all those blades under which it has already passed. But it rides over the top of the first of the blades which has fallen, and is thereby directed into the proper collecting box corresponding to the figure punched upon it. By various means, of course, the sorting machine may be made to reject all cards but those punched in a certain hole, say, the 4; or it may even be made to select out of a group only those cards punched with a certain number of eight figures or less; but whatever the operation, the principle of the selection remains the same.

The cards now being sorted into "major" groups of branch or area and "minor" groups of traveller, may be taken to the tabulating machine for an additive operation on "Net Value." It is, however, obviously necessary to make some provision for distinguishing between the different groups so that

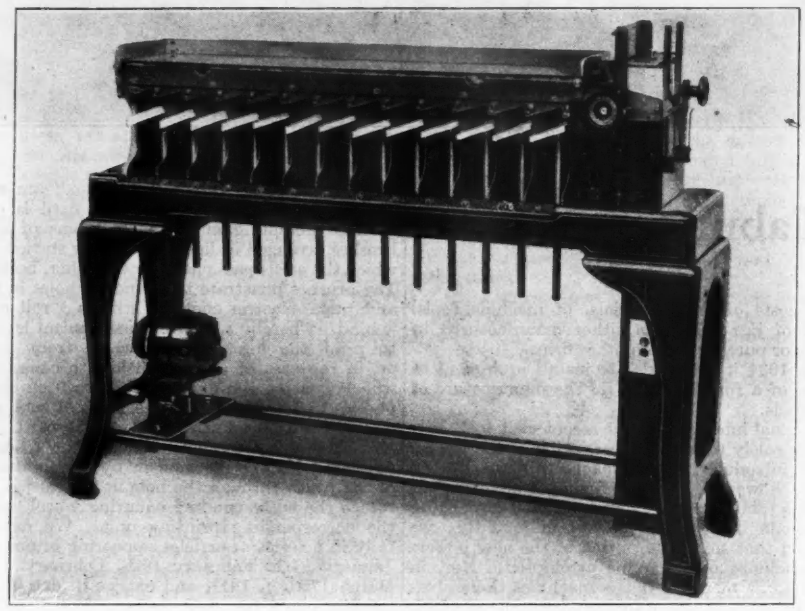


FIG. 2—SORTING MACHINE

the final printed record may show the total net value of the goods sold by each traveller; the total net value of the goods sold in each area; and the grand total of all the sales. Formerly this distinction was made by inserting a "stop" card between each group, the function of which was to stop the feed of the cards and cause the totals recorded on the counting banks to be printed before the machine re-started. This method of dealing with the problem was open to several objections, into which we cannot enter here, but which were fully discussed in an article appearing in our columns on March 14th, 1924. In that article the ingenious method by which the machine was made to detect for itself when the last card of any group had reached the sensing station was described. In essence it consisted of the provision of two sensing stations instead of one. These two stations were situated one immediately above the other at such a distance apart that the brushes of the upper station were traversing the same row of figures on one card as the brushes of the lower station were traversing on the card that immediately preceded it. In more technical language, the two sensing stations were one "cycle" apart. By this arrangement as described in the article it was possible to "compare" the punching of two adjacent cards and to cause the machine to stop the feed of the cards automatically if any difference was observed. Suitable relay circuits were then set up and the readings on the correct counting banks were printed before the machine re-started on the next group of similar cards. It is by just this provision of two sensing stations that the latest developments have been made possible. These developments comprise :—

(*a*) The ability to "subtract" the figure recorded on the cards from the counting wheels.

(*b*) The ability to select into which or from which counter or counters any figure punched in a certain field shall be added or subtracted.

(*c*) The ability to use a single counting wheel to record pence up to elevenpence instead of two, one of which only bears the figures 0 and 1.

(*d*) And indirectly has made possible the latest development—the "Rolling Total" machine.

SUBTRACTION.

A "Hollerith" tabulating machine is only adapted to add; it would introduce great complication if it was attempted to subtract by reversing the rotation of the counting wheels. The method adopted, therefore, is to add in the "complement" of the number which it is desired to subtract. This operation is most easily understood by a simple demonstration. Suppose the bank of counting wheels concerned shows a row of six figures and the reading is 005861, from which it is desired to subtract 543. Direct subtraction by the ordinary method gives the answer 005318, but the operation cannot be performed in this manner by the machine. Instead the complement of 543, which is 999456 (999999—543), is added, giving the resultant 005317, and to complete the process there is added in what is known as the "elusive one," giving the correct answer 005318. Mathematicians will recognise that the addition of the "elusive one" is necessary because the true complement of a number should be taken to 000000. But the use of the complement to 9 is more convenient in practice. Before the development of the tabulator with two sensing stations it was necessary for the girl who punched the cards to perform the operation of finding the complement mentally and punch the card with that complement. The objections to any such requirement are obvious. By the provision of two sensing stations, however, the "direct" figure may be punched on the card and the tabulating machine itself can be made to give out the complement. The operation is performed by a "Translator," the working of which is best demonstrated by a somewhat crude diagram—Fig. 4. Baldly stated, a "translator" receives a reading from the upper station and "transmits" it again, in complement as the card is passing through the lower sensing station. Its electrical connections are shown diagrammatically in Fig. 4. It will be noticed at once that the device is made in two precisely similar halves, and in actual fact it is mechanically driven so that it makes one revolution during two cycles, *i.e.*, two cards pass the upper sensing station while the translator is making one revolution. Taking the card shown in Fig. 1, suppose that the reading under "Net Value" is a debit transaction and that consequently it is to-be subtracted from the credit counter. Neglecting for the moment the shillings and pence columns and concentrating on the pounds, it will be observed that 873 must be subtracted. For each column there will be a separate "translator," *i.e.*, in the case under discussion there will be three such devices. Taking that for the digits only, the upper sensing station brush will drop through the punched hole at 3. A current then flows to a magnet set over a rotating disc, the translator, which contains ten plungers so placed that they move past the magnet in synchronism with the movement of the card past the brushes. Thus the card punched 3 energises the magnet just as No. 3 plunger on the disc is passing. This plunger is pulled out of position and takes with it a plunger on an inner ring. The inner ring plunger so moved is, however, not the third, as might be expected, but the sixth. It is, in fact, the complementary plunger to that pulled out of position in the outer ring. Thus as the translator continues to rotate its inner ring is "set up" with the sixth plunger projecting. A cycle later, when the card

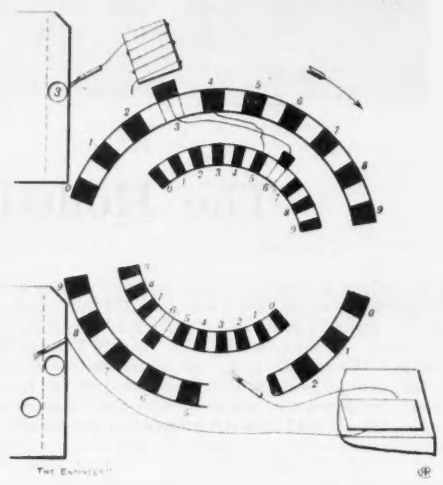


FIG. 4—DIAGRAMS ILLUSTRATING ACTION OF TRANSLATOR

that energised the plungers is passing the lower sensing station, the translator is required to "transmit" the information it has received to the counting wheels. As before, the translator is rotating in synchronism with the passage of the cards through the sensing stations. A brush is arranged at a little distance just clear of the inner ring of plungers and it makes contact with the projecting No. 6 brush just as the 6 row of the card is passing the lower sensing station. In effect the counting wheel receives from the translator an impulse exactly similar in every respect to that which it would have received, *viâ* the lower sensing station, from a slot punched on the 6 of the card. Thus since the brushes of the lower sensing station are disconnected from the counting wheels in a manner to be described later, the translator adds in to the counting wheels the complement of the figure actually punched on the card. At the end of the cycle, when the readings have been "transmitted" and before the disc comes round to "receive" its next reading from the upper sensing station, the plungers are mechanically reset into position. It should also be observed that while one half of the translator is "transmitting" the other half is "receiving" from the following card. The foregoing description is very crude, in that it represents the action as being performed by plungers. In actual fact, as may be observed from the engravings Figs. 5 and 6, the mechanism is far more delicate. A tiny pawl on the outer diameter of a disc-like assembly is "set up" from the card and thereby closes a circuit through a spring contact on the side of the disc to a commutator on which a brush connected with the counting wheel bears. A bank of translators as they are arranged in the machine is shown in Fig. 6.

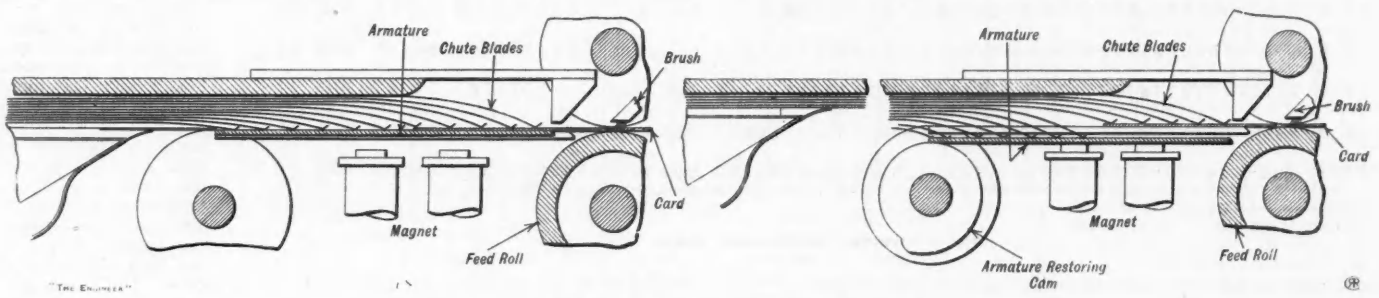
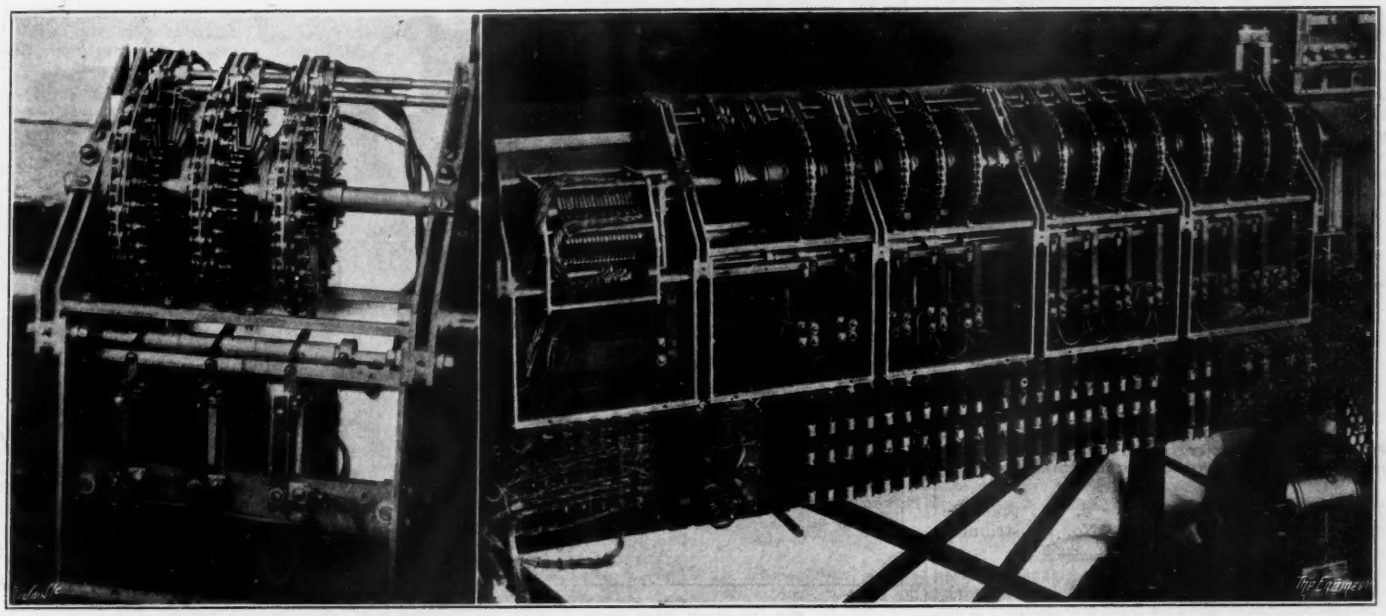


FIG. 3—DIAGRAMS SHOWING OPERATION OF SORTING MACHINE

THE PENCE COUNTER.

Besides the rows 9 to 0 on each card, there are available two other "points" above the 0 row, known respectively as the X and Y positions. As may be seen by reference to the engraving, Fig. 1, use is made of these points for recording 10d. and 11d.

But, quite obviously, punching the card in this position is useless so far as the lower sensing station is concerned, since all the counting wheels are disconnected after the brushes have sensed the 0 row. If, however, the reading of the pence column is made at the upper sensing station, and collected upon a special translator, the figures may be given out correctly one cycle later. A pence translator is so wired that, although it receives the 10d. and 11d. impulses last, it "transmits" the corresponding impulses to the counting wheel first. Each pence-



FIGS. 5 AND 6—TRANSLATORS MOUNTED IN BODY OF TABULATING MACHINE

counting wheel, naturally, has twelve numbers upon its periphery, and each pence translator is able to transmit an impulse at any of twelve possible moments while the card is passing the brushes of the lower sensing station from 9 to 0.

DISTRIBUTION.

It is possible by means of suitable punching and a suitable arrangement of circuits to cause a reading to be added into one or more of several different counter banks. For example, among a group of

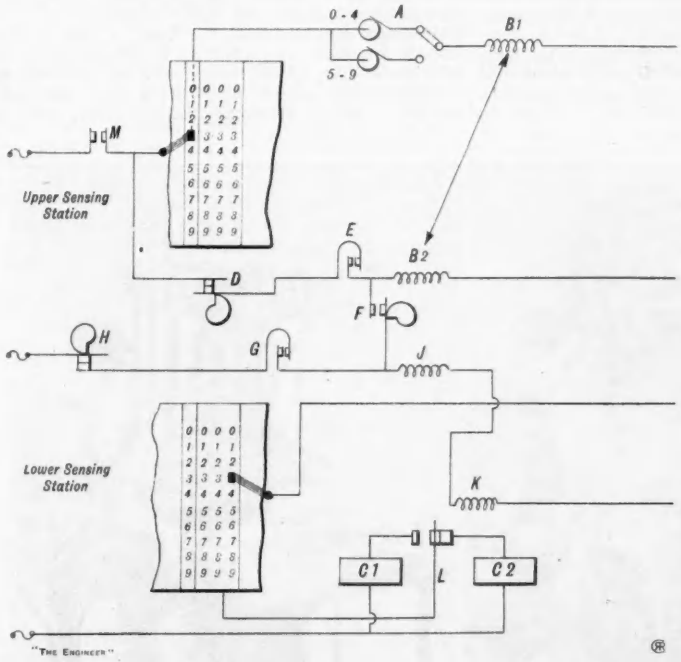


FIG. 7—CIRCUIT FOR DISTRIBUTION INTO TWO COUNTERS

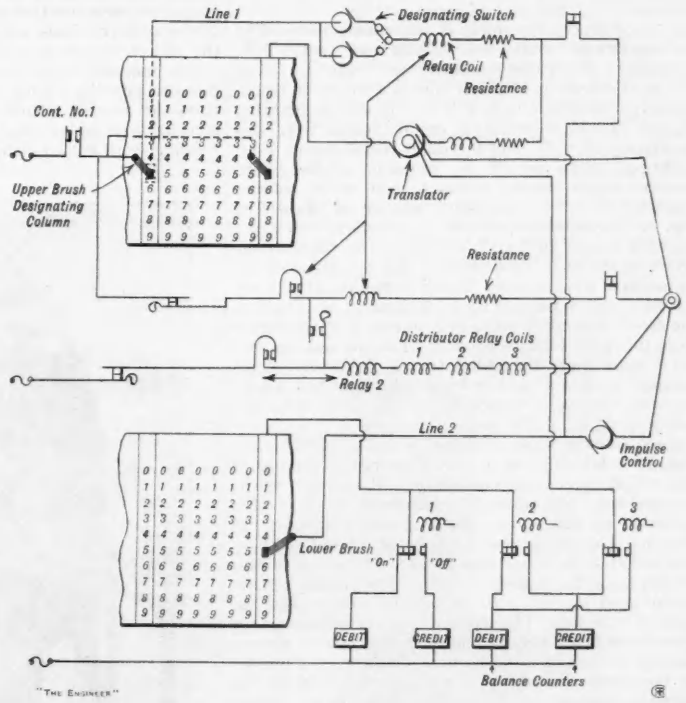


FIG. 8—CIRCUIT FOR DEALING WITH DEBIT AND CREDIT TRANSACTIONS

cards referring to one account, some may contain data in respect of piecework, whilst others may be in respect of daywork. Both daywork and piecework figures, however, may be recorded in the same field. It is desired to distinguish between them and to record the total of the piecework data on one counter and the daywork on another. This object is achieved by using one column of the card for a designation punch which will cause a "distributor" to operate. In essence, a "distributor" is a two-way switch operated by a solenoid. The principle is clear enough. If the card is punched in a certain manner in the designation column, a current is to be sent to the solenoid, whilst, if it is punched in another, no current is sent to it. In the first case, the reading found by the brushes in the additive field will be taken one way through the distributor to the daywork counter, and in the second the other way through the distributor to the piecework counter. Supposing, however, that the designating punch happened to be 0, it will be seen that practically the whole card would have passed the sensing station before the "distributor" was energised. It is clear, therefore, that the "distributor" must be operated from the upper sensing station, and the reading of the additive field must be taken from the lower. It is also obvious that the position of the distributor must not alter while a card is actually passing, but only in the spaces between the cards in spite of the fact that the designation punch which operates it may be anything from 0 to 9. These necessities introduce complications into the circuit which varies according to the purpose of the machine. A diagram of a typical circuit for passing a reading into either of two counters C 1 and C 2 is reproduced in Fig. 7. The principle is always the same. The punching of the designating column read at the upper sensing station sets up a circuit. This circuit, in turn, sets up that to the distributor just before the card enters the lower sensing station, and is itself shortly afterwards broken down. Where the reading can be passed into one of two counters, it is usual to arrange that any punch in the designation column from 0 to 4 shall pass the reading to one counter, and that any punched hole from 5 to 9 shall pass it into the other. The switch A in the diagram is arranged to distinguish between the punchings, and consists of two mechanically rotated discs, one of which "makes" a contact while the card passes beneath the brushes from 9 to 5, and the other of which "makes" from 4 to 0. When the machine is being arranged for a selective operation, connection within the circuit is only made through one of these two rotating discs. In the case under consideration the switch A is arranged to "make" for the rows 4 to 0, and as the card is punched 3 in the designating column, a circuit is "made" through a switch M, closed throughout the cycle (the function of which need not concern us) *viâ* the brushes at the upper sensing station, switch A and coil B 1 to the other side of the line. Coils B 1 and B 2 both act upon the switch E, which, owing to the pulse of current in coil B 1, is closed and is subsequently held closed by the flow of current in coil B 2. Towards the end of the cycle, and after the preceding card has passed the lower sensing station, the switch contacts F are momentarily closed by means of a cam. Current immediately flows through the coil J, causing the switch contacts G to close. Immediately afterwards, the cam-operated switch D opens momentarily, and breaks the circuit through coil B 2 and switch E, which consequently opens. In this way the circuit D, E, B 2 is prepared to be re-set-up by the next card, now entering the upper sensing station. Meanwhile, the card responsible for the operation of the relays is entering the lower sensing station, and it has set up for itself a circuit through switch H, switch G, and coil J to the solenoid K operating the distributor. The flow of the current in this solenoid causes the distributor to leave the

"on" contacts and connect up the brushes of the lower sensing stations through the "off" contacts with counter bank C 2. At the end of the cycle and just before switch F closes again, the switch H opens momentarily, thereby de-energising coils J and K, and causing the switch G to open. Should the designation punching of the next card be a 5, 6, 7, 8, or 9, the disc at A will not be making contact and, therefore, no pulse of current will flow through the coil B 1. Consequently, neither the circuit D E B 2, nor the circuit H.G.J.K will be set up, and the distributor thus remaining against the "on" contacts will take the reading from the lower sensing station into the counter C 1.

For some purposes it may be desired that the reading shall be led into any one of a considerable number of counters. This requirement is met by a multiplication of circuits similar to that shown radiating, as it were, from a switch A able to distinguish between a greater number of different punchings in the designating column and setting up different circuits according to the messages it receives. The distributors are arranged as shown in Fig. 9. This diagram shows all three distributors energised

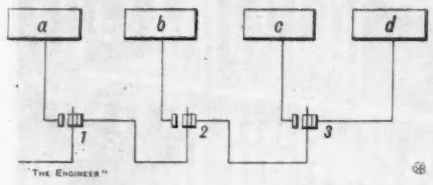


FIG. 9—ARRANGEMENT OF DISTRIBUTORS FOR DISTRIBUTION INTO SEVERAL COUNTERS

and the reading entering counter *d*. To take the reading into *b*, for instance, only No. 1 distributor would be energised.

CREDITS AND DEBITS.

The recording of credit and debit transactions is an interesting operation. Taking the case of the card reproduced in Fig. 1, it might be required to know how the accounts stood with each of several customers and to obtain a printed statement similar to the following :—

Customer.	Contract or order No.	Debit.	Credit.	Debit balance.	Credit balance.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.
54321	1234567	16 10 2			
54321	1234568	13 9 10			
54321	5342109		38 10 2		8 10 2
54322	1234569	16 8 1			
54322	1234570	15 17 2			
54322	5342110		16 14 4	15 10 11	

For this purpose the fields of the card concerned in the operations would be Contract or Order No.; Customer : Net Value ; and the tenth column, Dr. or Cr., to distinguish between the two kinds of transaction. Punching a 0, 1, 2, 3, or 4 in this designating column would indicate a credit transaction and punching a 5, 6, 7, 8, or 9 a debit transaction. Four counting banks would be required dealing with credits, debits, credit balance, and debit balance respectively. The necessary circuit is shown in Fig. 8. This diagram, it will be observed, is in many respects similar to Fig. 7, differing principally in the arrangement of the distributors and by reason of the inclusion of a translator. It will be realised that when a credit card is passing its reading must be added to the credit and credit balance counters and subtracted from the debit balance counter while the reading of a debit card must be added to the debit and debit balance counters and subtracted from the credit balance counter. Consequently the reading in the additive field of the card is sensed at the upper sensing station and "stored" on a subtracting translator which gives it out to the credit balance or debit balance counter according to the nature of the transaction. The three distributors, it will be found, operated by the relay coils 1, 2, and 3 all move in unison. Except for the inclusion of several switches concerned with operations outside the scope of this description, the diagram is sufficiently similar to that reproduced in Fig. 7 to be understandable without further reference. The selective powers of the machine also come into play, although the necessary circuits are not shown on the diagram. As soon as a change in customer number is "sensed" the feed of the cards is stopped and the total credit or debit balance printed. The dials are then "wiped" clean by reset mechanism and the feed of the cards is restarted on the new customer number.

If it was desired, two extra counting banks could be arranged interconnected with the credit and debit balance counters. When the four original counters were "wiped" clean these two additional counters would be unaffected. In this way the grand total debit or credit balance could be obtained for transactions with a large group of customers. Again, to develop the possibilities still further, these grand totals might be caused to be printed for each of several different districts by causing a selective mechanism to operate upon a change in the district number. What is termed major and minor control would then be obtained, the minor control distinguishing between different customers and the major between different districts. In fact, the possibilities are so great that when a new development in the design of the machine takes place it may take a considerable time for the research staff at the works fully to analyse the inherent possibilities of the improvement.

ROLLING TOTAL.

At the present moment an analysis of such possibilities is taking place with regard to what is termed the "rolling total" machine. The name arises from the power the machine possesses of taking the reading recorded on one counter bank and "rolling" it into that recorded on another. The advantages of the system may be weighed from a consideration of a series of cards bearing in two separate fields data concerning the selling price and manufacturing cost of a certain article and in two further fields the value of articles returned and their cost of manufacture. It is required from these data to find the actual net profit of the transactions recorded by the series of cards in each of several districts. Only four banks of counters are required on which as each group of card concerned with one district passes the figures on each of the additive fields are added and recorded. When the end of the group of cards is reached the reading of the manufacturing cost counter is rolled in complement into the selling price counter and at the same time the cost of returns is rolled into the value of returns in complement. The state of the counters, reading from left to right, is now :—1, Net Profit on Actual Sales ; 2, Cost of Manufacture ; 3, Net Value of Returns ; 4, Cost of Manufacture of Returns. Next the resultant of the previous rolling operation on the "returns" counters, *i.e.*, the figures borne by counter 3, is rolled into the selling price counter, *i.e.*, Counter No. 1, in complement, the final result upon the latter counter being the net profit. This last figure is then printed. The counters are next "wiped" clean by the addition of complements and the machine restarts on the next group of cards. The rolling operation is performed in a manner analogous to the method by which the readings are transferred from the counters to the printing bank. Instead, however, of energising the bars of the printing mechanism, the current flowing is taken to translators, which give out the necessary complements to the bank of counters into which the total has to be rolled.

In this short account of the developments that have recently taken place in Hollerith tabulating machinery many of the possibilities have necessarily not been referred to. Nor has any mention of special machines, such, for instance, as those used for a census of population been made. Nearly all the machines, however, are of a more or less general purpose type, such that they are capable of performing a number of different operations chosen as suitable to his requirements by the customer. In the body of the machine there is a plug board, by the use of which a practised operator can rapidly rearrange the connections of the various translators, distributors, &c., to give any desired result within the capacity of the particular machine concerned.

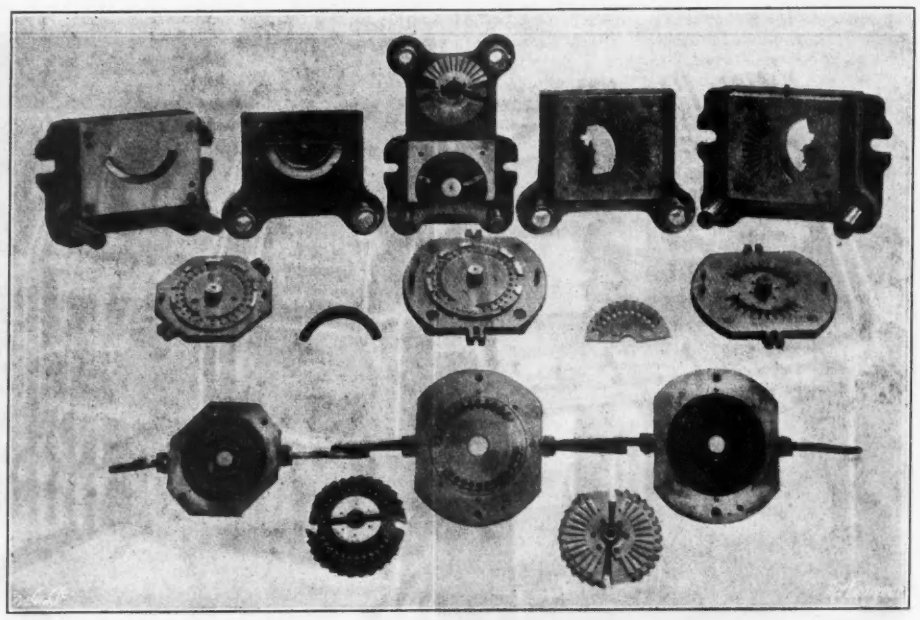


FIG. 10—JIGS AND TOOLS USED IN PRODUCTION OF A PENCE TRANSLATOR

THE WORKS.

The works in which these tabulating, punching, and sorting machines are made is illustrated by a photograph reproduced at the head of this article, and by a number of engravings in a Supplement to this issue. The actual works may be regarded as divided broadly into two parts, in the largest of which the machines themselves are manufactured, while in the other the cards for use with the machines are made. When it is realised that in each machine many of the parts are absolutely identical in construction—there may, for instance, be twelve or more "translators," a large number of distributors, several dozen resistances, as many similar assemblies of identical parts for transferring totals to the printing mechanism as there are counting wheels, and so on, in a single tabulator—it might be thought that the works would

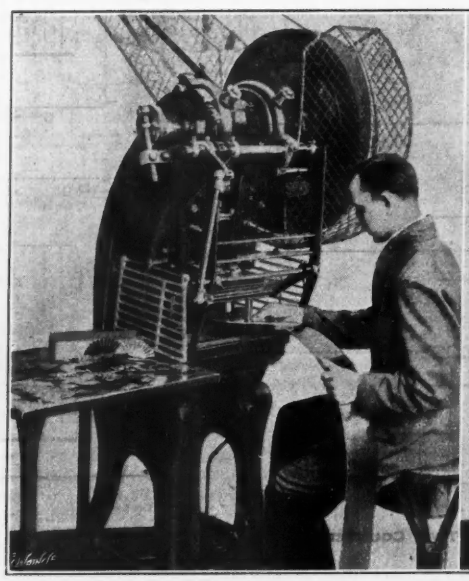


FIG. 11—STAMPING OUT STAR SPRING OF TRANSLATOR

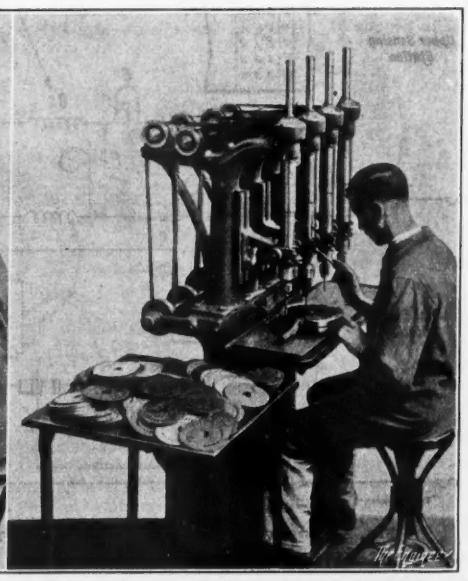


FIG. 12—USING DRILL JIG

be organised for mass production. The demand for tabulating machinery, however, is not great enough to make the installation of mass production machinery worth while, but, instead, the general principle of group production predominates. For the construction of a very large number of parts there are special jigs, fixtures, and tools. In the tool stores, for instance, we found, kept in special boxes, gangs of milling cutters, each specially set up for some special job. As a typical illustration of the manner in which parts are made, the manufacture of a pence translator may be studied. There are no less than 358 parts in the complete assembly, many of them, of course, being little nuts and screws. Some of the jigs and tools used are illustrated in Fig. 10. Engineers familiar with pressing, punching, and drilling operations will follow out the use of each appliance without much difficulty. At the bottom views of a completely assembled translator from the back and front are given. The punching dies and drill jig for a small arc-shaped piece are to be seen on the left, while the centre and the lower right-hand side are occupied by drill jigs for other parts. In the top right-hand corner the punching die for the contact spring "fan" is to be seen. This part is made from 0·012in. spring steel. After the punching operation, which may be seen in Fig. 11, these springs are specially plated as they supply current to contact studs. The use of one of the drill jigs is shown in Fig. 12.

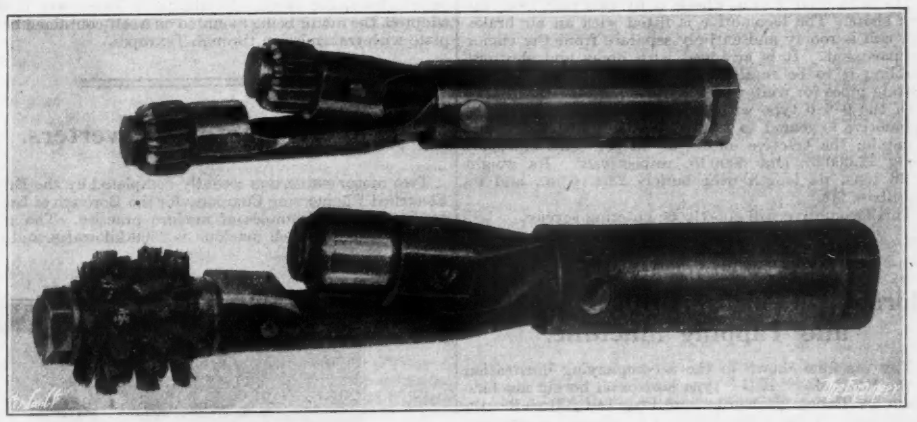
As will be seen from the engravings reproduced in the Supplement, the men work under the best of conditions in well-lighted shops. That engraving illustrating the assembly shop demonstrates clearly the complexity of the wiring in each machine; a complexity, be it noted, with which the customer is not concerned. When wiring up little labels are tied upon the end of each wire if it is impossible at that stage to complete the circuit. Before the machine is sent out to do its work it is exhaustively tested to make certain that every circuit is correctly wired, and every relay correctly set to operate at the right moment. No possibility that a mistake might be made can be tolerated.

One of the most interesting parts of the works is that concerned in the production of the cards for tabulating machinery. The plant is illustrated by two engravings in the Supplement. Three specially designed slitting machines are the first to come into action on the rolls of paper as they arrive from the manufacturer. Each roll weighs about 600 lb., and is slit by the machine into seven or eight reels of the desired card width according to the width of the original roll. The edges of the roll which may have suffered damage are slit away and re-rolled, together with the reel cut to the correct size of the cards. While the slitting is in progress, a sensing mechanism is brought into play which seeks any impurities, particularly metallic impurities, in the paper. If any such content is found, a knife is brought down and that particular part of the reel is torn so that it is useless for the production of cards. From the slitting machines the reels of paper having a width equal to that of the cards, are taken to printing machines of which several different types are in use. The machines in the foreground of the engraving in the Supplement are of the platen type, and produce cards at the rate of about 6000 an hour. Nearly every customer requires different information to be printed on the card, so that a large number of different blocks from which cards may be printed have to be kept in stock. After printing, the strip is cut off into separate cards, which are collected in a container. One operator can attend to three or four of these machines. In another type of machine information can be printed on both the back and front of the card during the same feed. The most rapid producer is that type of machine which uses a cylindrical printing die, which is "rolled" on the paper. As many as 24,000 cards an hour can be produced by machines of this type, and one man can attend to two machines. In every case the machine is able to number the cards consecutively, and, at the same time, counts them independently so that a check is obtained on the correctitude of the numbering of the cards. Before they are packed up for transmission to the customer, all the cards are carefully inspected. Accuracy of cutting is of the greatest importance, since not only must the cards be exactly the right length, but also the figures must be correctly placed in relation to the ends. As each card passes through the machine, a fairly thick line is printed at the point where the knife should cut the strip to form the card. During subsequent inspection of the card, it is usual to be able to find a trace of this line right at each edge of each card. If, however, the line can be found in full at a distance from one edge of the card, some fault has occurred, and the card must be rejected.

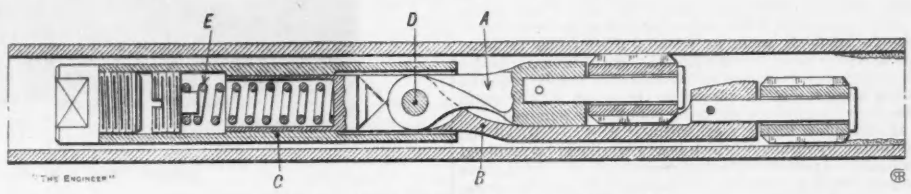
THE ROAD AND RAIL TRAFFIC ACT, 1933.—The issue, free, by the British Road Federation, of 50, Pall Mall, London, of a booklet by Frederick G. Bristow, Barrister-at-Law, dealing with the provisions of the Road and Rail Traffic Act, 1933, as it affects commercial motor users, is likely to be welcomed by many owners of goods vehicles, manufacturers, traders, and road hauliers who are not very certain of their ground with regard to the provisions of the Act. The booklet deals in particular with those sections of the Act concerned with the licensing of vehicles.

A Condenser Tube Scaler.

THE condenser tube scaler illustrated herewith has recently been produced by F. Gilman (B.S.T.), Ltd., of 221, High-street, Smethwick. The tool is driven by a rotary flexible shaft, and comprises two arms A and B, pivoted into a tubular casing C at D. The rear end of each of these arms finishes with an apex near the pivot. Behind and engaging with these apices there is a conical plunger, which is urged forward by the spring E, and consequently presses the ends of the two arms outwards. It will be noticed that the arms are so formed that they fit together to give a small overall diameter. The arms carry fixed spindles on which tools appropriate to the work in hand are mounted. In the tool engraving the tool is, in one case, shown equipped with a wire brush on one arm for removing soft deposits, and with a plain roller on the other arm to keep the brush up to its work. In the other case both arms have serrated cutters for breaking up hard scale. It should be pointed out that the makers do not claim that these tools will remove excessively hard scale, but that they are intended rather for routine maintenance purposes.



GILMAN CONDENSER TUBE SCALER



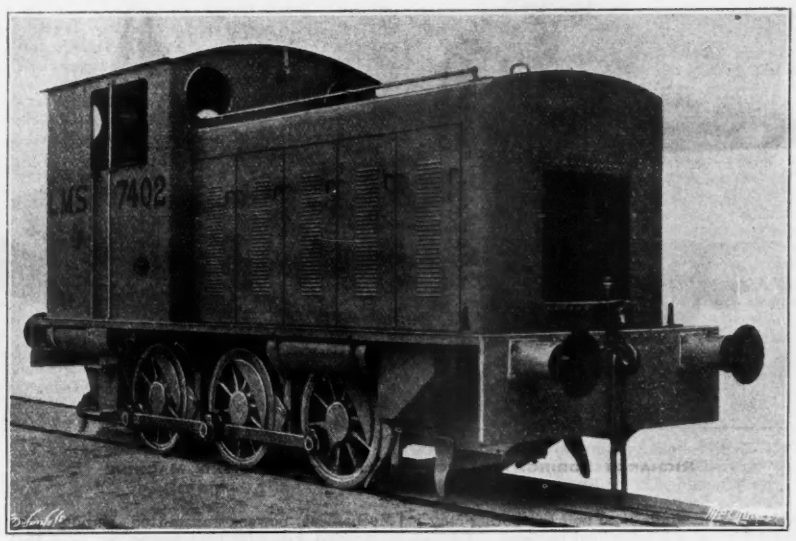
SECTIONAL ARRANGEMENT OF TUBE SCALER

Oil Locomotives for L. M. and S. Railway.

OF the four oil shunting locomotives which the L.M.S. Railway ordered earlier in the year from the Hunslet Engine Company, Ltd., of Leeds, the second is now completed, and is illustrated in the accompanying engraving. The engine is an eight-cylinder McLaren unit, and is built especially to suit locomotive construction, with a special bedplate casting, machined to fit between the frames. The brake mean effective p essure at full load is 83 lb. per square inch, whilst the output is 150 H.P. at 1000 r.p.m. The starting of the main engine is accomplished by means of a "Scott" twin-cylinder petrol engine, which can be controlled, started, and stopped, &c., from the cab, although it is placed under the main engine casing. The main engine is fitted with decompression gear. When a speed of about 200 r.p.m. has been attained the valves of the main engine are dropped and it fires immediately. The starting gear is thrown out of operation automatically at the same moment.

The gear-box extends for the full width between the frames and like the engine is located by fitted bolts in reamered holes. Following usual Hunslet practice, the gears are of the constant mesh type, mounted on ball and roller bearings. Change of gear is effected by heavy dog clutches. The gear change is made by the "Hunslet" automatic pre-selective mechanism, which is complete in itself and is bolted on to the outside of the gear-box, adjacent to the control shafts which operate the dog clutches by a twisting movement and not by a push-pull action. The mechanism is complete with a small pair of cylinders capable of moving the gear into position when oil pressure is applied. The oil is passed through a selector valve, also bolted to the gear-box, which is controlled by a preselective gear lever from the cab, and passes the oil to whichever cylinder it is desired to operate. The pressure is supplied by means of a small intensifier operated by compressed air, the compressed air valve being coupled up with the clutch pedal. The operation is as follows:—

The clutch is operated by a pedal and the first portion of the stroke disengages the main clutch. The preselective change gear lever has already been placed in the correct position, thus selecting the valve as explained. During the latter portion of the clutch pedal stroke, the air valve to the intensifier is opened and pressure is immediately transferred to the oil, which passes through the selected valve and on into the operating cylinder. The gear then goes over into position and the clutch pedal is released. The gear can never be moved until the clutch is completely disengaged. When engaged in any gear the mechanism on the gear-box is such that the valve automatically selects the requisite cylinder to bring the gear into the neutral position upon the next operation of the clutch pedal, irrespective of the position of the preselective gear lever. This arrangement ensures that the gear cannot be crashed straight across from one ratio to another. To change from one ratio to another, the next gear is engaged on the preselective gear lever at the driver's



HUNSLET OIL LOCOMOTIVE FOR L. M. AND S. RAILWAY

leisure. Two separate depressions of the clutch pedal are then made, the first bringing the gear into neutral, the second engaging whichever gear has been selected. During a slight interval between these two operations, the throttle is either shut off when engaging a higher gear or opened up when engaging lower gear.

On the locomotive the selector, throttle, and clutch pedal operations are all air controlled, so that the driver is only called upon to operate one hand wheel, the cycle of operations then taking place automatically. All controls without exception are duplicated on both sides of the cab, and the locomotive can be driven equally efficiently from either side.

The final drive to the wheels is by side rods from the jack shaft. The locomotive is fitted with an air brake. The cab is roomy and entirely separate from the engine compartment. It is arranged with doors and shutters, enabling it to be totally enclosed if necessary and has heating pipes for winter use.

Of the 0–6–0 type with 3ft. 4in. diameter wheels, the locomotive is geared to run at speeds of 4·5 m.p.h. and 9 m.p.h., the tractive efforts at 85 per cent. efficiency being 12,000 lb. and 6000 lb. respectively. Its weight is 26 tons, its length over buffers 25ft. 0½in., and its wheelbase 9ft.

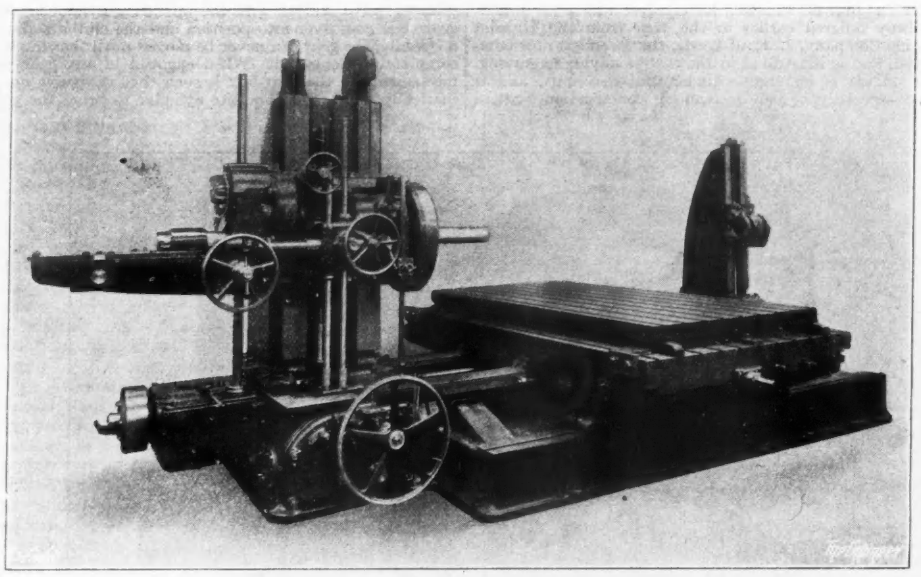
This locomotive will shortly be entering service.

Horizontal Boring, Milling, Drilling and Tapping Machine.

THE machine shown in the accompanying illustration is the No. 4 size "H B" type horizontal boring machine made by George Richards and Co., Ltd., Broadheath, Manchester. It has a 4in. diameter spindle and is provided with an extra wide bed and greatly increased table accommodation. The bed is 6ft. 3in. wide and carries a saddle upon which is mounted the main or sliding table, 8ft. 9in. long by 5ft. 6in. wide. The latter has a cross traverse on the saddle of 7ft. 3in. On this main table can be mounted either a special revolving table, 8ft. long by 4ft. 6in. wide, or two square independent revolving tables, each 42in. by 42in. The special revolving table has been provided to enable long units to be machined along their sides with the table in position, as shown in the engraving. Without disturbance of the casting the table can be turned 90 deg. to bring the end of the casting opposite the spindle for other operations. When this table is not required it can be replaced by one or by two smaller square revolving tables placed on the main table. The use of two tables is very convenient when large batches of identical units have to be dealt with, as while work on one is being machined the other is being loaded. Both these top tables are exactly the same size and should only one be required at any time it can be placed in the centre of the main table, the other, of course, being completely removed.

An ingenious lifting mechanism is provided to all the top tables, by means of which heavy work can be revolved with ease. Accurate squaring devices are also fitted, thus ensuring absolute squareness between all sides of the work.

Rules and verniers are fitted to the sliding units, *i.e.*, to the spindle frame vertically, to the traversing spindle horizontally, to the table transversely, and to the boring stay bearing. By this means adjustment to these units is rapidly and accurately made. The provision of magnifying glasses greatly facilitates the reading of these verniers. The spindle of the machine is 4in. diameter, bored No. 6 Morse taper, and has a traverse of 30in. It adjusts to 36in. above the revolving table and it is interesting to note that the boring stay bearing has an automatic vertical movement synchronising with the spindle. The maximum



RICHARDS BORING, MILLING, DRILLING AND TAPPING MACHINE

distance between the spindle nose and the boring stay is 10ft. and the table has a longitudinal traverse of 4ft. 9in. Tee slots are provided on the front of the driving gear, which is mounted on the spindle sleeve, to which milling cutters, &c., can be clamped direct. The spindle has twelve speeds ranging from 10·2 to 300 r.p.m., and twenty-four feeds ranging from 0·0034in. to 0·248in. per revolution of spindle. In addition, no less than twelve different milling feeds are available at each independent speed. Thus there is a total range of 144 such feeds ranging from 0·044in. to 12·4in. per minute. Rapid power traverse is, of course, provided on all motions, whilst all sliding units, including the boring stay bearing, have hand adjustment, a lever being provided to disengage the power motion to the latter. The spindle frame constitutes a completely enclosed unit, from the mechanism of which is excluded all cuttings and other foreign matter. The bed mechanism is likewise fully enclosed and in all cases easy and rapid access to the working parts is provided for. The main shears of the bed are provided with covers to protect them from damage by cuttings, &c., and the main bed screw is also fully covered. A chute is provided at the back of the bed for convenience in disposal of the cuttings.

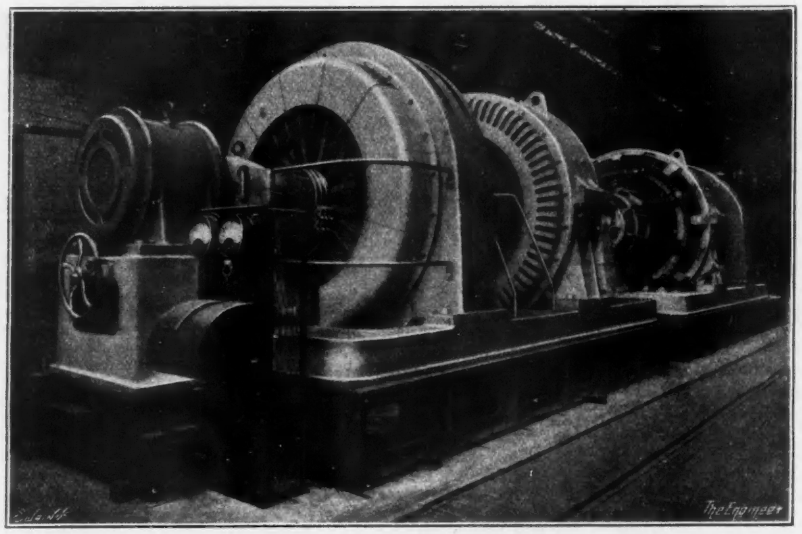
The illustration shows the machine arranged for single-pulley drive, but direct electric motor drive was finally adopted, the motor being mounted on a self-contained base-plate with transmission through Texropes.

2500 kW Motor Converters.

Two motor converters recently completed by the Brush Electrical Engineering Company for the Borough of Luton are interesting examples of modern practice. The continuous rating of each machine is 2500 kilowatts, and the overload capacity 25 per cent. for two hours. Both machines are designed to convert 50-cycle, three-phase current at 6000/6600 volts into D.C. at 500/550, the speed being 500 r.p.m. There are four poles on the A.C. side, and four poles on the D.C. side, and as the two units, forming a complete machine, are connected in cascade, according to the well-known principle, the eight poles give the synchronous speed mentioned. It is well known that in machines of this kind the power is transformed to the D.C. side partly mechanically and partly electrically. Mechanical power transmitted through the shaft is converted into electrical power, as in a D.C. dynamo, whilst that which reaches the D.C. armature by way of the cascade connections is converted in accordance with the principles of a rotary converter.

The combination of a rotary converter and D.C. generator in one machine results in a higher efficiency than that obtainable with a motor generator, and greater stability than that of a rotary converter. Compensating windings in the pole faces neutralise armature reaction, and thus assist commutation by preventing field distortion. To ensure intimate and stable contact of the brushes with the commutator surface, the brush holders are designed to incline the brushes at an angle of 30 deg. against the direction of rotation, whilst, to ensure that the commutators will present a stable running surface, they are subjected to intensive heat treatment in the works, and are run for prolonged periods at higher speeds and temperatures than those attained under actual operating conditions. The A.C. portion of each machine is constructed on the same lines as an induction motor. One end of each of the twelve rotor phases is connected to the D.C. armature by leads passing through the hollow shaft, while the opposite end of each phase is taken to a short-circuiting device on the shaft, which provides means of opening the phases for starting, and of joining them to a common star point for running. Slip rings are provided for connecting the mid-wire of the three-wire D.C. system to common star point of the rotor windings, so that out-of-balance current flowing in the mid-wire of the system can return to the positive or negative side *viâ* the rotor and armature windings. The frames of both machines are composed of welded steel plates, and those of the D.C. portions are in two parts to facilitate dismantling.

Starting and synchronising are carried out by the Brush Company's patented method, which provides means of starting from rest and automatic synchronising follows the closing of the main switch without further switching or attention from the operator. As is well known, the natural speed of the A.C. end of a motor converter is above the normal running speed, and the speed is definitely locked at the normal value by the synchronous action of the D.C. unit. For this reason it is possible in the ordinary way for a motor converter, when being started, to run above speed before it is synchronised, but this effect is avoided in the Brush Company's system by a small pony motor interconnected with the rotor of the main A.C. machine in such a way that the number of poles are additive, and even during starting the speed is limited to the normal value. As the speed of the set accelerates to the normal value, the pony motor assists in setting up synchronising torques which cause the motor to fall into synchronism with the A.C. supply naturally, and the machine can be put into service within sixty to ninety seconds from the time of starting from rest. One of the motor converter sets built for the Borough of Luton is shown in the accompanying illustration.



BRUSH 2500 KW MOTOR CONVERTER FOR LUTON

BOOKS OF REFERENCE.

The Year Book of the Scientific and Learned Societies of Great Britain and Ireland, 1933. London: Charles Griffin and Co., Ltd., 42, Drury-lane, W.C.2. Price 10s. net.—The publishers are to be congratulated upon this, the fiftieth edition of a year book which has proved itself to be a definite necessity to all libraries and scientific institutions. The general lay-out of the new volume is similar to that of last year, in which, it will be remembered, the papers read before the various societies during the previous year were not listed. The particulars of the societies have been revised and they include details of membership, officers, meetings, subscriptions, &c.

The "Practical Engineer" Electrical Pocket Book and Diary, 1934. Edited by Conrad Arnold, A.M.I.E.E.; and *The "Practical Engineer" Mechanical Pocket Book and Diary*, 1934. Edited by E. G. Beck, A.M. Inst. C.E., &c. London: The Oxford University Press, Amen House, Warwick-square, E.C.4. Price 2s. 6d. net each.—This is the thirty-fifth edition of the "Electrical Pocket Book," and the sections dealing with Testing and Testing Instruments and Measuring Instruments, Single-phase and Polyphase Alternators, Electric Motors, and the Transmission of Power have been revised and in part re-written. "The Mechanical Pocket Book" is in its forty-sixth year and numerous amendments and additions have been incorporated in the new edition.

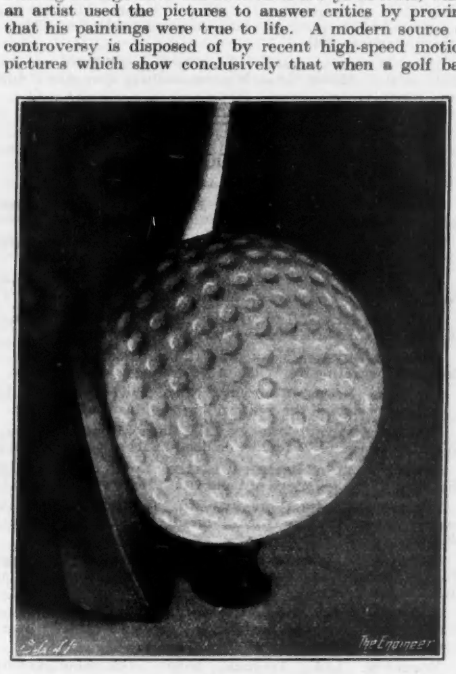
THE Board of Trade returns show that last year we exported 11,400 tons of sewing machines, as compared with 6500 tons in 1932.

Seeing the Fourth Dimension.*

HIGH-SPEED photography is now being employed in the plant and laboratory as a means of magnifying time, conventionally the fourth dimension in all physical existence. Pictures may be taken at the rate of 6000 per second, and projected at the normal rate of 16 per second, thereby requiring about 6 min. to reproduce action which has taken place in 1 sec. Various methods have heretofore been developed for taking pictures of moving subjects at practically any rate of speed. It is only recently, however, that commercially practicable means have been developed for taking a sufficient series of high-speed pictures consecutively to permit their projection as motion pictures or their use in adequately studying more than the briefest phenomena.

Exposure times, furthermore, have now been shortened to 1/1,000,000 of a second, in which very little movement can take place. For example, the edge of a 20in. wheel rotating at 10,000 r.p.m. would travel only 1/100 of an inch in that time, although it would be moving at a velocity equivalent to about 570 miles per hour. Improved light sources are being used. Experimentation with a great variety of subjects, ranging from snakes' tongues and flies' wings to the formation of chemical materials, has developed a versatile technique for getting useful pictures and then securing significant information from them.

In 1872 Leland Stanford began investigating the gaits of horses by means of a battery of cameras with shutters electrically operated in quick succession. The earliest recorded case of using "high-speed" photographs for settling an argument was in Paris a few years later, when an artist used the pictures to answer critics by proving that his paintings were true to life. A modern source of controversy is disposed of by recent high-speed motion pictures which show conclusively that when a golf ball



IMPACT OF CLUB AND BALL

is driven it remains in contact with the club for about 1/5000 of a second, or for less than ½in. of travel.

One picture may be worth a thousand theories, especially if action, which is a confused blur to the human eye, can be "stopped" at a critical instant or slowed down on a motion picture screen to allow careful and unhurried study. Turbulent water can be made to assume a lava-like viscosity. The bursting of a bubble is resolved to an almost leisurely movement.

Analysis of a series of golf pictures yielded considerable technical information about drives made by Mr. Francis Ouimet. Inasmuch as a great many machine design questions are susceptible to the same sort of technical analysis, the types of data secured in the golf ball experiments are of industrial significance. Back-spin varied from 3500 to 7200 r.p.m. The lightest of the three clubs used gave the ball a velocity of 194ft. per second, 8·5 per cent. greater than in the case of the heaviest club. In every drive the initial velocity of the ball was appreciably greater than that of the club. The energy stored in the club, the efficiency of impact, the ratio of energy in rotation to that in translation and the ratio of actual velocity to theoretical velocity for perfectly elastic bodies in collision were all derived from a detailed analysis of the film.

By similar means, time and motion studies for the purpose of locating hidden causes of imperfect operation have been made of complicated machinery in which a complete cycle of several operations requires only a fraction of a second. Acceleration and deceleration data are readily obtained for machine parts with rapidly varying speeds. For example, angular displacement studies have been made of generators and motors under conditions of instantaneous disturbance, such as are caused by lightning.

Patent attorneys are now able to illustrate in a non-technical way highly technical points involved in litigation by showing the court a slow-motion movie properly provided with sub-titles. Research and development engineers have a convenient means for making tests and comparisons, and it is entirely possible that radically new principles of design will be suggested by action photographs, when their function as a supplement to theoretical reasoning and cut-and-try methods is more fully appreciated. For example, aviation engineers now have a means of observing the wing action of insects, which might conceivably materially affect future airplane construction.

A future of industrial usefulness is apparently in store for high-speed photography—applied to time as the microscope and telescope have been applied to space.

* From the *Industrial Bulletin* of Arthur D. Little, Inc., Cambridge, Mass.

The Evolution of Invention.*

By H. W. DICKINSON.

Introduction.—It is desirable in the first place to decide precisely what we mean by invention, the word having several distinct connotations, as we might otherwise be led to some confusion of thought. Originally it meant something come upon by chance and quite easily, a concept of the word which is popular, but which, as will be shown later, is erroneous. Invention in the more modern acceptation of the word has three meanings, which may be defined thus: (1) the thing schemed or contrived; (2) the mental processes involved; and (3) the ability to evolve the new scheme or contrivance, commonly called inventiveness. In what follows in this paper the first definition will be that referred to, but in the other papers comprising this symposium the other two connotations of the word will be intended.

We may therefore say that invention presupposes existing knowledge based on experiment and observation. It is perhaps too broad a generalisation to say that the inventive faculty is an inherent attribute and its exercise a vital function of animated nature, but at any rate other animals becides man possess it, although man is preeminently the inventive animal and is not, as Carlyle put it, merely the tool user.

An invention essentially has parts and properties not possessed by the elements from which it has been evolved, and here the broad distinction between discovery and invention can be observed. The former is the apprehension of the order of Nature, whilst the latter is the guidance of the known forces of Nature into new channels for the benefit of man. Discovery precedes invention perhaps by thousands of years, as did the observation that vapour rises from boiling water and the utilisation of that phenomenon in the steam engine; or perhaps by only a short time, as in the case of the application of Faraday's discovery of electromagnetic induction to the dynamo, where the interval was only thirty-nine years. It is not always easy to define the line of demarcation between discovery and invention, because invention frequently leads to fresh discoveries, as Watt's invention of the steam engine led to discoveries in the science of thermodynamics.

Discovery is made quite apart from the thought of possible utilisation, whilst an invention is evolved for a specific purpose. All social, economic, physical, technical, and commercial developments are the result of invention, and we may say that civilisation is a synthesis of the inventions made by man since his appearance on this planet a million years ago.

It is obvious that the field for the exercise of the inventive faculty is practically without bounds, and it is fortunate that we are limited to a consideration of only one aspect of it, namely, that of technical invention. We need not therefore discuss the philosophy of invention or what use, good or evil, man makes of it.

Historical.—Much has been written on the problem of invention, and there is in existence a considerable literature of the subject of which only the fringe can be touched in a paper such as this. No very satisfying answer has ever been given to the questions: Why does man invent; what motive actuates a man to devote his whole life to the laborious pursuit of an object (from which he may derive little or no benefit) which, when accomplished, enables others who have contributed nothing to enjoy all the benefits of his toil? The simplest answer, which is by no means complete, but which has withstood much argument, is to be found in the old adage "necessity is the mother of invention." The inventive faculty is present, but requires the force of circumstances to call it to life.

The fundamental inventions, fire, shelter, pottery, and the use of metals, belong to prehistoric times. The simplest mechanical powers, the lever, the wedge, and the inclined plane, belong also to those times, as does the harnessing of animals to do work. A most important stage was reached by man in early times when he brought under control for his use the great forces of Nature, water and wind. It is to be observed that the harnessing of these elements would not be attempted until a demand arose for a larger power unit than was provided by an animal. The need would arise when water had to be pumped in quantities for irrigation. To this early period must belong the roller and its derivative the wheel, and the remaining mechanical powers, the wheel and axle and the pulley. The wheel is surely the most capital invention of all time, for it is a concept which could not be derived from animated Nature where reciprocating motion alone is exemplified. In Greek, and in Roman times particularly, mechanical invention appears to have progressed rapidly, *e.g.*, the improvement in the plough, but on closer examination the progress appears to have been due rather to social and economic developments, such as division of labour, good administration, increase in means of communication (bringing contact with the civilisations of the East), and stable commercial conditions. The mechanic arts were then, as they were with us until quite recently, looked upon as ignoble.

In the Middle Ages throughout Europe progress resulted from the slow spread of new and the improvement of old industries, and the progress of invention during the last five centuries has been one of ever-increasing extent and rapidity, as is well known.

Encouragement of Invention.—At what period definite encouragement was first given to invention by individuals, corporations, or sovereigns it is difficult to say. We know that in the Middle Ages England was mainly an agricultural and mining country, and was far behind the Continent in her manufactures. In spite of this, or perhaps because of it, England can furnish the first known instance—in 1331—of encouragement being given—by the granting of letters of protection—to the introducer of a new process. We are obliged to admit, however, that the precedent thus set was followed but sparingly during the succeeding fifty years. With the accession of the House of Tudor (1485) a policy, characteristic of those kings, appears to have prevailed, namely, that of attracting into the service of the Crown skilled artificers from abroad: armourers from Germany, shipwrights and glass-makers from Italy, and ironfounders from France. In the reign of Elizabeth the policy of introducing new industries into the country, not necessarily to be worked by foreigners, under the protection of the Crown was steadily pursued. Upwards of fifty grants of monopolies for such industries are known to have been made in her reign.

In Stuart times the needs of the Crown for money led to such grants being made frequently for industries already in being, and hence to intolerable abuses, which, however, were swept away by the Statute of Monopolies, 1624. This Act has been the basis of our own patent system and indeed the model of those of other countries. Little more need be observed here of the patent system, which will be treated of more fully later, but it is the opinion of the author that, in spite of its drawbacks and anomalies, no better system of fostering invention has been devised than that of grants of letters patent to the inventor. If support is needed for this view it will suffice to mention that the Dutch, who abolished their patent system in 1869, were obliged, after a period of stagnation or even of retrogression, to re-establish it in 1912. Since that date the industrial development of Holland has been remarkable.

The Rationale of Invention.—It is a generally accepted view that invention has its birth in inspiration; rarely does it spring from the observation of Nature, but rather does it come from the careful elaboration, refinement, or simplifying of the original idea by the first and succeeding brains until at last it reaches practical shape. Here one is inclined to make a distinction between capital or primary, and derivative or secondary inventions. Of the former mention has already been made of the wheel, but other instances are movable type, rollers for drawing textile fibres, the filament lamp, the lens, and wireless transmission. The distinction is perhaps only one of degree, but it is important because the capital invention opens the gate to new fields in which derivative invention can proceed for a long time. It is probable that less than 1 per cent. of all the inventions can be classed as capital.

An invention, when made, may not satisfy a pressing need and be abortive in consequence, but it is not true to say that specific invention is not wanted. The world may be unconscious of a need until the means to satisfy it are at hand, when the need itself at once becomes apparent. The telegraph and telephone are instances of the truth of this proposition. It has not infrequently happened that the translation to practical purposes of an idea has been impossible, being beyond the mechanic arts of the day. That was a difficulty more commonly met with in the early days of invention than now. The steam engine, from Hero of Alexandria to Savery, called for boilers that could withstand a pressure of three or four atmospheres, but the construction of such boilers baffled the skill of the artificers of the period. Newcomen, by utilising steam at a pressure only just above one atmosphere, was successful with his engine. And it is probable that Watt would have experienced greater difficulty than he did in introducing his separate condenser engine had he not been able to use a cylinder boring machine, invented by John Wilkinson just at that time, which was capable of greater accuracy than had previously been possible. Breech-loading cannon were made in the sixteenth century, but were of no military use, as there existed at that time no means of making the breech gas-tight. It would be possible to adduce innumerable instances of this form of limitation of development.

An article embodying an invention may be too costly to produce in small numbers. For instance, in the seventeenth century only the wealthy could afford to purchase sporting rifles. However, when small arms were required in large numbers for war purposes the interchangeable system of manufacture was developed, and the Army rifle became feasible. Rifles were first produced on "mass production" lines in 1815 at Connecticut. It may be remarked here that warfare, or the periods of preparation for it, has in all ages led to great inventions; no matter how costly might be the development and production of new engines of war or their auxiliaries, inventors could always rely upon ample funds for their purposes. And the technique so evolved has in peace time led to striking developments. It is significant to note that the first successful typewriter, the Scholes and Glidder, was manufactured by the Remington Arms Company in 1875.

We are thus led to the consideration of three aspects of invention. The first is the machine or apparatus which is to function; the second is concerned with the tools, the materials, and the knowledge which is required to bring the machine or apparatus to practical shape; and the third aspect concerns the conditions which govern the reception of the invention. These aspects determine the length of time of the embryo stage of the invention.

It seems that tools can always be devised if the object is worth while, and the Wilkinson boring mill has already been cited as an example. There is also the instance of Nasmyth, who devised his steam hammer to forge the paddle shaft of the s.s. "Great Britain" in 1839. It is interesting to note that the hammer was not in fact used for its intended purpose, as it was decided to adopt the screw propeller instead of paddles for the vessel and the propeller shaft was built up from boiler plate. The question of materials is not always easily settled, and mention might be made of the development of light alloys for aircraft and the instance given later of the development of crucible steel for watch springs. Knowledge of physical phenomena is of great importance in invention, and lack of it may retard development. The early history of the internal combustion engine, which is well known, is a striking case in point. The first experiments were made in 1794, but it was not until 1862 that the compression of the working fluid was recognised as essential and an engine working successfully on the modern four-stroke cycle was not constructed till 1876.

Sometimes only a detail is necessary for the success of an invention, and we might instance the U-leather packing which was perfected shortly after the time the hydraulic ram came into use and which immediately ensured the success of the ram, or the discovery by Richard Arkwright of the appropriate kind of leather for the drawing rollers in spinning machinery thirty-seven years after the introduction of such machinery by Lewis Paul, or again the interval of two centuries between the invention of the breech-loader and the cartridge case which made it practicable. It not infrequently happens that in developing a machine an essential detail may have to be devised, and may prove to be the subject of an earlier invention which has been overlooked, as was the case with the locomotive blast pipe.

With regard to the third aspect, namely, the reception of the invention, whilst it was necessary to refer to it as a

* The Institution of Mechanical Engineers, January 19th.—Symposium of papers on Invention.

logical complement of the other two, a discussion of it would be inappropriate under the title of this paper, and is therefore better left for treatment under another heading.

It may be observed here that, whereas ideas may come freely, the development of them is often laborious in the extreme, and the greatest credit is deserved by him who brings an invention to a successful issue. Failure to recognise the differences between the early and late stages of an invention leads to much ill feeling, and it should be realised that, particularly in the case of primary invention, the application of many minds is necessary for the development of an idea from inception to practical use.

Aids to Invention.—It has been mentioned above that existing knowledge based on observation and experiment are pre-requisites of invention, and knowledge of the state of the arts both at home and abroad may be a great stimulant. It is noteworthy that sensational accidents or unusual occurrences are followed immediately by a large influx of applications for patents connected in some way with them, as, for example, devices to prevent fires at sea and for the protection of property following upon the "L'Atlantique" disaster and the epidemic of "smash and grab" raids. The condemnation of "shuttle-kissing" led directly to a number of applications for patents for self-threading devices. With the present limit of fifty years beyond which anticipation of patented devices is not reckoned, it might be worth while to examine the specifications prior to that period for the discovery of ideas which, though good, failed commercially at the time of their invention. There are valuable stores of information in libraries such as those of the institutions and the Patent Office, nor in the search for knowledge and ideas should the contents of our technical museums be overlooked. Too much stress, however, should not be laid upon the acquisition of vast knowledge by the inventor, as many great inventions have had their inception in ignorance of what had already been accomplished in their fields. Too great knowledge tends to paralyse initiative.

Observation and experiment have already been mentioned as pre-requisites of invention. James Watt observed the great loss of heat in the atmospheric engine and in experimenting to ascertain the cause of the loss discovered that important property of steam—its latent heat. It was long before the idea occurred to him of condensing the steam in a vessel separate from the cylinder. Actually ten years passed before the invention was successfully embodied in an engine. Charles Babbage, the inventor of the difference engine, who endeavoured to enunciate the laws of thought governing man's inventiveness,* cites observation as one of the principal determinatives. He says: "Whenever we meet with any defect in the means we are contriving for accomplishing a given object, that defect should be noted and reserved for future consideration and inquiry should be made—*whether that which is a defect as regards the object in view may not become at once of advantage in some totally different subject.*" He had been watching an exhibition of electric light from a battery and had noted the occurrence of accidental interruptions, which suggested to his mind a mode of sending signals by light. By a simple mechanism he devised occultation of the source of light and suggested the application of the principle to lighthouses.

More than once a suggestion has been made that information regarding the failures and disasters of inventors and their experiences should be recorded and filed for reference in some central institution, as an inspection of such records by would-be inventors would save them time and money. Why, it is asked, should the road be travelled repeatedly by successive inventors? Apart from the impracticability of the proposal, the answer is that were such knowledge recorded, it would probably be known only to the historically minded and to older men who are past the inventive age, and if resorted to by the younger men would most likely act as a deterrent to them.

It seems that an inventor must be young. A study of the lives of inventors shows that in contradistinction to those of litterateurs and artists the best creative age is between twenty-five and forty years, and there is scarcely an exception to this dictum. Sir Charles Parsons was thirty when he developed his steam turbine. Besides youth, enthusiasm and even monomania are prime factors in producing successful inventions, and much has been accomplished in the past by men in pursuit of one idea. John Fitch (1743–1798) was throughout his life obsessed by the idea of navigation by steam, but not everyone is prepared like Bernard Palissy, the potter, to sacrifice his household furniture in the furnace which held his final and successful experiment in his new art of ceramics. It may be noted here that the examination system as regards inventiveness operates largely as a dead hand.

In devising a mechanical movement to replace by machine work previously carried out by human or animal agency it is wise to avoid imitating Nature. Nature works reciprocatively, whereas the machine works rotatively. Early attempts at steam propulsion of vessels by means of the duck-foot paddle proved a failure, whereas the reversed water wheel was effective, but not so efficient as the less obvious screw; Brunton's locomotive propelled by jointed legs was on entirely wrong lines; and it is submitted that, except for gliding, the ornithopter has no future. The hand saw was transformed into the frame saw, but it is in the circular and band forms that the saw has its widest application.

The "hit and miss" method of perfecting an invention appears occasionally to achieve success, but seems to be more appropriate in research laboratories and for the evolution of secondary inventions. It is true that Charles Goodyear, who was a merchant when he was attracted to study the properties of india-rubber, spent ten years experimenting with all kinds of substances before he discovered that sulphur was the agent necessary to effect vulcanisation.

It would appear to be no disadvantage to an inventor to be outside the industry in which his invention is to find scope, as he has no preconceived notions to overcome. Benjamin Huntsman was a clockmaker who wanted better steel for his springs, and to obtain it he was constrained to invent crucible steel. Metallurgy affords other instances of this principle: Henry Cort was a navy agent when he invented the puddling process for wrought iron; Henry Bessemer had invented a perforating press for the prevention of forgery and a bronze paint which was highly successful before he brought out his pneumatic process for producing ingot iron from pig iron. Instances could be multiplied, but mention should be made of Arkwright, who was a barber before he applied himself to the problems of spinning.

Retarding Influences.—It is almost unnecessary to speak of conservatism and complacency as a clog on invention. Man reacts instinctively against innovation. The mediæval trade guilds did not favour invention, generally through fear of reducing employment or of admitting inferior work. Many of us have experienced rebuffs when we have pointed out defects and possible ways of improved working in practice of long standing where vested interests also contribute their share of opposition to change. Where an invention is labour saving, workmen will be found to oppose it even where the work which it is intended to save is exhausting and slow, and the reception of Koenig's newspaper printing machine illustrates this point. This reaction of labour differs in different countries; in the United States from the first workmen have been willing to embody skill in the machine and so admit of interchangeable manufacture, whereas in Great Britain the opposite attitude has been taken more than once, but is now less frequent.

The influence of professional authority may also operate as a clog on progress. For the first half of the nineteenth century the development of the steam engine was slow, engineers of that period being of the opinion that Watt had delivered the last word on the subject.

Conclusion.—When we survey the large number of capital inventions made since man first started on his quest to control the forces of Nature, allowance must be made for the view that invention must inevitably slow down. Progress seems to take place according to a geometrical law, for the technical advances made since the middle of the eighteenth century have been as great or greater than those of all the time which preceded it, and it must be the feeling of the older men whose experience is necessarily greater that the field for invention is now wider than ever, but whether the direction will lie in technical achievement or in social or economic realms is not for us to prophesy.

* "Passages from the Life of a Philosopher," 1864, page 452.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

MEDIUM-HARD COPPER STRIP, BARS AND RODS.

No. 518—1933. This Specification is similar in form and scope to the B.S. Specification No. 444 for Plain Dead-soft Copper Strip, Bars, and Rods. It prescribes the minimum conductivity, the tolerances permissible on the dimensions of the strip, bars, and rods, and the physical properties as shown by tensile hardness, and bend tests. The forms and dimensions of the test pieces are specified, and the procedure for selecting test samples for the electrical and mechanical tests is detailed. In an appendix a table of temperature coefficients of resistance is given.

FIBRE CORES FOR WIRE ROPES.

No. 525—1933. So far as is known this is the first attempt made to standardise wire rope fibre cores which have been responsible for many instances of wire rope failures. The central fibre core in any wire rope is at least equal in importance with the wires in the strands; inferior or unsuitable fibre cores impair the integrity of wire ropes and greatly reduce their endurance in service. Fibre cores are heavily compressed during the closure of the rope, and, in addition, have to withstand stresses in service due to the working load and the flexure of the rope. They must support the wire strands so that there is no undue mutual abrasion of the wires in adjacent strands, and also must provide an elastic bed to allow relative displacement and deformation of the wire strands when the rope is flexed round a sheave. Concealed from view unsuitable fibre is liable to unobserved disintegration. Moreover, experience has shown that internal corrosion in wire rope may be directly attributable to inferior or unsuitable fibre central cores. Hence, cores should be as nearly as possible free from salt and acid; some fibre is inherently acid and the presence of soluble salt is obviously undesirable.

Commercial fibres vary considerably in salt content; for example, it is found that untreated Manila fibre is normally much higher in salt content than certain Empire fibres, such as New Zealand hemp. Absolute neutrality as to acid and total absence of salt is virtually impossible to attain with any fibre, but careful selection, appropriate treatment, and due care, prior to or in process of manufacture, render it possible to produce fibre cores for wire ropes limited as to salt and acid content. The specification includes maximum limits for salt and acid content, and describes methods for the chemical determination of salt and acid.

It is recognised that, to comply with the provisions of the specification as to salt and acid, it is necessary for manufacturers of wire rope fibre cores to follow a regular system of testing in connection with their purchases of raw fibre. To standardise such testing, recommended methods for sampling the fibre in the bale and for routine works tests for salt and acid are given.

It is well known that all fibre ropes readily absorb moisture from the atmosphere. Saturation of dry fibre cores with lubricant, in addition to providing central lubrication for the wires of the rope, prevents the re-absorption of moisture by the core.

While the circumference of the central or main fibre core in a six-strand round strand wire rope is specified to be approximately one-half the circumference of the wire rope, the actual size of the core depends somewhat upon the kind of fibre and the degree of hardness with which the core is laid. For a wire rope of equal circumference, cores made from soft fibre are normally larger than cores made from hard fibre.

To ensure absence of abrasion between the adjacent strands of wire rope, the size of the central fibre core should be such as to allow feeler penetration between the adjacent strands of a new wire rope; this affords proof that adjacent wire rope strands do not initially bear upon each other, and makes allowance for the further compression of the central fibre core when the wire rope is subjected to service conditions.

There exists considerable discrepancy of opinion as to the most suitable kind of fibre to be employed for any particular wire rope. The specification allows latitude in the selection of fibre cores for engineering and colliery wire ropes, while imposing minimum standards of quality.

LAUNCHES AND TRIAL TRIPS.

LOCH, single-screw steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Polish British Steamship Company, Ltd., of Gdynia, Poland; dimensions, 292ft. by 40ft.; to carry passengers and cargo. Engines, triple-expansion, pressure 210 lb. per square inch; constructed by the builders; launch, January 15th.

DEVONSHIRE, single-screw tug boat; built by Cammell Laird and Co., Ltd., to the order of London, Midland and Scottish Railway Company; dimensions, 95ft. by 26ft. by 13ft. 6in.; to carry sixty passengers and towing. Engines, direct-acting compound, pressure 130 lb. per square inch; constructed by the builders; launch, January 18th.

RAMSDEN, single-screw tug boat; built by Cammell Laird and Co., Ltd., to the order of London, Midland and Scottish Railway Company; dimensions, 95ft. by 26ft. by 13ft. 6in.; to carry sixty passengers and towing. Engines, direct-acting compound, 130 lb. per square inch; constructed by the builders; launch, January 18th.

GREAT WESTERN, steamer; built by Cammell Laird and Co., Ltd., to the order of Great Western Railway Company; trial trip, recently.

CATALOGUES.

FIBRAX, Ltd., 2, Tudor-street, E.C.4.—Catalogues of brake and clutch linings.

SKEFKO BALL BEARING COMPANY, Ltd., Luton.—Illustrated price list of tapered roller bearings.

A. C. WICKMAN AND CO., Ltd., Coventry.—Catalogue sheet No. W. 3 on the British-made Monforts automatic.

FERGUSON PAILIN, Ltd., Higher Openshaw, Manchester.—A booklet on the firm's fabricating and welding service.

ASHMORE, BENSON, PEASE AND CO., Ltd., Stockton-on-Tees.—A leaflet illustrating the Wilhelm self-sealing coke-oven doors.

NEWBURY DIESEL COMPANY, Ltd., Newbury.—A leaflet giving particulars of the "Sirron" type of marine oil engine.

GENERAL ELECTRIC COMPANY, Ltd., Magnet House, Kingsway, W.C.2.—A descriptive booklet on flood-lights and flood-lighting.

CELLACTITE AND BRITISH URALITE, Ltd., 296–302, High Holborn, W.C.1.—Details of Cellactite "Medway" ventilators.

IGRANIC ELECTRIC COMPANY, Ltd., Bedford.—Leaflet 450 on accessories for use with "Igranic" electric controlling devices.

THOS. BROADBENT AND SONS, Ltd., Central Ironworks, Huddersfield.—A booklet illustrating centrifugals for all industrial purposes.

BRITISH PISTON RING COMPANY, Ltd., Holbrook-lane, Coventry.—A catalogue on "Brico" hardened cylinder liners, centrifugal castings, and pistons.

ETHERIUM, Ltd., Terminal House, Grosvenor-gardens, S.W.1.—A copy of "The Feed-water Treatment for Steam-raising and other Industrial Plant."

STURTEVANT ENGINEERING COMPANY, Ltd., 147, Queen Victoria-street, E.C.4.—Publication No. 1076 on mechanical draught for boilers, furnaces, and kilns.

THOS. SMITH AND SONS (RODLEY), Ltd., Rodley, Leeds.—Folders dealing with an oil-engine-driven general purpose mobile crane and locomotive steam cranes.

BRITISH TRANE COMPANY, Ltd., Vectair House, Newcastle-place, E.C.1.—Two brochures on the Vectair system of heating for offices, hotels, theatres, and industrial buildings.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., Millbank, S.W.1.—A publication giving detailed practical information on the use of silicate of soda for the surface hardening of concrete.

WALTERS ELECTRICAL MANUFACTURING COMPANY, Ltd., Kensal-road, W.10.—Details of the Moore and Knight system of public fire alarms, ambulance, and police signals.

HADFIELDS, Ltd., East Hecla and Hecla Works, Sheffield.—Publications 359 on crushers for glass works, and No. 360 on portable stone breaking plants for road construction and other purposes.

GOLF CHALLENGE CUP.—Sir Robert Hadfield, the President of the Engineering Golf Society, has intimated that he will present a Golf Challenge Cup to be competed for annually by past and present students of Faraday House Electrical Engineering College. Old students can obtain further particulars from the Registrar of Faraday House.

PUNCH AND CHISEL SET.—We have to thank Fry's (London), Ltd., 24/25, King-street, London, E.1, for a set of small punches and chisels, carried in a handy metal clip, and packed in a carton. The clip holds a 6in. by $\frac{1}{4}$in. cold chisel, a 5in. by $\frac{1}{4}$in. cold chisel, a 6in. by $\frac{1}{4}$in. by $\frac{1}{16}$in. brad punch, a 5in. by $\frac{1}{4}$in. by $\frac{1}{4}$in. brad punch, and a 4$\frac{1}{2}$in. by $\frac{1}{4}$in. centre punch. The tools are British throughout and the set, which is known as the Enox, is far from expensive.

ELECTRIFICATION OF A WROUGHT IRON WORKS.—An interesting industrial event took place last week at the works of the Midland Iron Company, Ltd., Rotherham, when Mr. Geo. Baker, President of the Rotherham Chamber of Commerce, set in motion a 500 H.P. motor to drive the forge mill. The 8in., 9in., 10in., and 16in. mills were electrified a few years ago, and this completes the electrification of the rolling mills by which the works have attained a unique position in the wrought iron industry.

THE LATE MR. ALBERT WOOTTON.—Mr. Albert Wootton, who died on January 7th, at the age of ninety-two years, will be remembered by some of our older readers as being connected for many years with the Falcon Engine and Car Works, Loughborough. The latter part of his time was spent as general manager at the Brush Works. He was one of the founders, along with his two brothers, of the Coalville Ironworks, near Leicester, and he served as chairman of the directors practically up to the time of his death.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Pig Iron Market.

The demand for pig iron has strengthened during the past ten days, and once again there is heavy pressure upon the producers, particularly on the North-East Coast. The position is still tight and the makers are avoiding as much as possible quoting for forward delivery, partly on account of the increasing cost of production and partly because of the difficulties of ensuring adequate supplies of coke. Many consumers, more especially the important users, are well covered; but they all appear anxious to supplement their existing contracts with additional purchases. The outstanding feature of the situation is the efforts which are being made to increase the production of foundry iron. A furnace is being restarted at Skinningrove and another at the Redcar Works of Dorman, Long and Co., Ltd., and it is expected that a second furnace will be put into operation at the latter company's works shortly. Preparations also are being made to put in an additional two furnaces at Dorman Long's Newport works during the next few weeks. It is doubtful, however, if more than one of these furnaces will be put on to produce foundry iron for the open market, so that the output is not likely to be increased sufficiently to cover the existing demand for this class of iron. Further coke ovens are preparing to restart, but in the meantime the demand has been so strong that prices have advanced to 20s. per ton d/d furnaces for good Durham blast-furnace coke, and more than this is required in some cases. Business in hematite iron also is active, and here again there is hesitation on the part of producers to sell at current prices. They have little iron in stock and the general appearance of the market seems to indicate that an increase in prices is probable. The Midland makers are experiencing a heavy demand, which is strengthened by the scarcity of Cleveland iron, causing users to look to Midland brands. In some cases Northamptonshire producers have practically withdrawn from the market, and this has turned the demand in the direction of Derbyshire iron, of which heavier stocks are in existence. In Scotland business in pig iron is expanding, and it is probable that two blast-furnaces will be restarted at the Gartsherrie Ironworks of Wm. Baird and Co., Ltd. This will increase the number of furnaces in blast in Scotland to twelve.

North-East Coast and Yorkshire.

Business in the finished steel department of the market has broadened considerably during the past fortnight or so, and encouraging reports come from all the producing districts. The greater interest shown in the market by consumers may be due in some measure to rumours of an advance in prices. A section of the market seems to expect that the present level of quotations for steel which has ruled for the past four years will soon be raised, but apparently the steel makers are not by any means unanimous on this point, and questions of policy may lead to these increases being delayed for a time. If costs continue to rise, however, and the demand remains on the present scale, such a movement would seem to be almost inevitable. On the North-East Coast orders reaching the manufacturers have shown a tendency to increase in volume, but complaints are still heard of the miscellaneous character of the business which has been transacted. A good demand for constructional steel has sprung up recently, although the makers on the North-East Coast seem to have been better off in this department for some time than those in other parts of the country. Work for the railways is also keeping the mills well employed and specifications for steel arising from the recent orders for ships are now reaching the works on a good scale. The weak spot in the market is the poor demand for sheets, which has declined recently, particularly on export account. In Yorkshire the works are operating in some cases at capacity and the general conditions of the industry is satisfactory, the more so that a number of works have sufficient orders in hand to keep them fairly busy for the next few months. The price of open-hearth acid steel billets has been increased by 5s. to £9 7s. 6d. basis. It is interesting to note that the production of steel in Sheffield during November, the latest month for which returns are available, was 102,800 tons, which is a record for several years. The production of stainless steel also is increasing and there is a steady demand for alloy steels. A feature of the market of late has been the demand for hot-rolled strip, but at the same time a good business has been transacted in the cold-rolled qualities.

The Midlands and South Wales.

The gradual broadening of interest in the Midland steel market encourages the belief that the prospects for 1934 are unusually good. One of the more cheerful signs is the recent increase in the demand for plates, as business in this material has lagged behind the improvement in other departments of the market. No doubt the plate mills can still do with more work, but the position is definitely better than it was in December. The constructional engineers in some cases are not well off as regards orders, but one or two firms are working on important contracts, and as a result the steel works are experiencing a fair demand from this section of the industry. The decision at the Sheetmakers' Conference not to advance prices was not unexpected, as recently business in this material has declined, although there has been a fairly good home demand for the heavier gauges. The market for small steel bars has been quieter of late, but the re-rollers have good contracts in hand. Competition is met with from the Continent in this branch of the trade, and the recent advance in Continental quotations to £6 15s. 9d. has not affected the volume of business going abroad, since the disparity between the British price of £7 10s. to £8 and the Continental price, which includes delivery and import duties, is too substantial to be ignored by consumers who are accustomed to use the foreign material. Business in strip continues to be one of the features of the Midland trade. Practically all the works producing this class of material have good order books and some are practically off the market for the time being. In fact, the majority of the works have extended their delivery periods. A rather brighter tone has developed in the South Wales market, as the demand for tinplates has taken a turn for the better. The works quoting 16s. have now sold as much as they care to at this figure and the minimum quotation is 16s. 3d. to 16s. 6d., f.o.b. 20 by 14 basis. A fair export business has been done with Canada and Australia and some of the Continental markets. Last week a meeting of the British, American, French, and German tinplate makers was held in Paris to explore the possibilities of reaching an agreement regarding export markets and prices.

Scotland and the North.

Cheerful conditions rule in the Scottish steel market. Orders for three tankers have been placed on the Clyde, the firms obtaining the contracts being the Blythswood Shipbuilding Company, Ltd., Harland and Wolff, Ltd., of Govan, and Lithgows, Ltd. It is expected also that other shipbuilding contracts will be secured shortly. Most of the heavy steel works are busy as a result of the improvement in the shipbuilding industry, and these new orders point to a continuance of active conditions. The wagon building firms in Scotland also are anticipating fresh orders from the railways. As in other districts, the sheet industry is passing through a period of slackness. The home demand for the thicker gauges has been moderately well maintained, but export business has been distinctly poor since the beginning of December. The Scottish re-rollers are experiencing competition from the Continent and are not nearly so busy as the English works producing similar material. Perhaps one reason is that the Scottish re-rollers' official price for small steel bars is £7 15s., against £7 10s. quoted by the English re-rollers. The Motherwell Bridge and Engineering Company, Ltd., has secured orders for bridge work for South Africa, the Near East, and Iraq, which will keep the firm busy for some time to come. The Lancashire steel industry complains of the comparatively few heavy contracts which are being placed; but, on the other hand, there is a good volume of business in small orders. Much is heard, however, of the variety of specifications included in most orders, which necessitates frequent changing of the rolls and a consequent increase in cost. Little fault can be found with the demand for the lighter materials, including bars, hoops, and small sections, and in this department the manufacturers are not anxious to accept forward bookings. The structural engineers are rather more busy than they were, and as a result some fairly substantial business has been placed with the steel works. The demand for alloy steels, which has been on a good scale for months past, shows little signs of relaxing, and most of the machine tool makers are actively employed.

Machinery Imports and Exports.

The exports of machinery in 1933 compared favourably with those of 1932. There was an increase in the value of agricultural machinery sent abroad, the total for last year being £767,828, compared with £620,135 in the previous year. By far the most important consignments went to countries in Europe, which took agricultural machinery to the value of £334,200. The exports of boilers and boiler-house plant reached £1,500,757, compared with £1,422,763 in 1932. The value of cranes, hoists, and other lifting and excavating machinery exported amounted to £694,395, a considerable drop from £1,304,584 in 1932. The value of electrical machinery sent abroad was £2,638,010, compared with £3,641,917 in the previous year. Machine tools for metal working also showed a decline to £1,266,780 from £3,144,124 in 1932, the decline being almost entirely due to the smaller exports to Russia. The value of prime movers sent out of the country totalled £1,983,717, compared with £1,672,477 in 1932. Of this amount South Africa took machinery valued at £189,665, Indian purchases reaching £389,035, and Australian £130,350. Textile machinery was exported to the value of £3,385,781, against £3,767,343 in the previous year. Exports also included three war vessels of 1453 tons displacement, valued at £254,928; and ten steam vessels of 39,361 tons displacement, valued at £1,698,519.

Current Business.

A new gasometer of the spiral guided type, having a capacity of 4,000,000 cubic feet, is to be erected at Middlesbrough. The contract for its erection, subject to the approval of the Middlesbrough Town Council, has been awarded to Ashmore, Benson, Pease and Co., Ltd., of Stockton, and the cost will be £37,249. The tender is in conjunction with the Tees-side Bridge and Engineering Company, Ltd. For the foundation work the tender of Industrial Constructions, Ltd., of Westminster, S.W.1, for £7063 has been recommended for acceptance. The gas supplied will be contracted for through the coke oven plant at Dorman, Long and Company's Newport Works. The Department of Overseas Trade announces that the following contracts are open for tender:—Australia, City of Mackay, Queensland: supply, delivery, installation, testing and maintenance of electrically driven pumping equipment, with accessories, piping, valves, steel work and sundries (Australia, May 1st); Posts and Telegraphs Department, Melbourne: insulated wires (Melbourne, March 13th); and totally enclosed metal-clad switchgear (Melbourne, March 12th); New Zealand, Public Works Tenders Board, Wellington: one set 110-kV and one set 33-kV outdoor switching equipment, steel work for same (Wellington, March 27th); also four mimic bus panels to control four 110-kV oil circuit breakers (Wellington, April 24th); Egypt, Ministry of Public Works: 25-kW, 110-volt direct turbo generator set for the Royal yacht (Cairo, February 12th); South Africa, Government Supplies Board: underground armoured cables, covered wire, copper wire, &c. (Pretoria, February 16th); South African Railways and Harbours: fog signalling plant, including one Diesel engine driven D.C. generator; one D.C. motor-driven 150-cycle A.C. generator, and one atmospheric emitter with accessories (Johannesburg, February 26th). The Department of Overseas Trade has received an inquiry for the names of manufacturers of steel houses.

Lead and Spelter.

Disappointing conditions continue to rule in the lead market. Prices advanced last week owing to the movements of the exchange, but the improvement was short-lived, and when the American statistics, which showed a considerable increase in the stocks at the end of December, were published, values again declined. The total stocks were given as 203,100 tons, compared with 187,800 tons at the end of November. On the other hand production during December was 41,300 tons, or 2600 tons less than in the previous month. The worst part of the statistics was the decline shown in the deliveries, which fell to 26,000 tons, a reduction of 4700 tons on the month. British consumers have shown rather more interest in the market of late, most of the demand coming from the manufacturers of lead pipes and sheets, although the battery makers are also again taking larger quantities. At the current low prices there is an inclination to believe that the worst of the position has been seen, and that any price movement must be upwards. . . . The spelter market has been lifeless, and, in fact, there has been little change in the general situation during the past few weeks. The demand shows some signs of improving, but supplies are abundant, and whilst this condition rules any sustained upward movement cannot be expected. The European Spelter Cartel endeavours to keep production in line with consumption by means of substantial penalties inflicted upon firms who exceed their quota. Some surprise, therefore, was occasioned recently when it became known that it was more profitable for a Belgian firm to pay the fine and produce in excess of its allotment than to work to its quota. It is possible that this may result in a readjustment of some of the conditions of the Cartel later on.

Tin.

This market has had a rather lifeless appearance for some time, and prices have moved within narrow limits. The expectation that American buyers would enter the market on the appreciation of the dollar exchange was unfulfilled, transatlantic buying having been on a disappointing scale. It is possible that the decline in operations at the American tin-plate works is responsible for this, as the demand for tin-plates normally falls off at this period of the year. Purchases by Continental interests also have not been important, whilst in this country buyers have limited their purchases to comparatively small quantities. In some quarters of the market it is suggested that the formation of a "buffer" pool with the object of stabilising prices has been responsible for the lack of speculative interest shown in the metal. It is not unusual for quiet conditions to rule at this time of the year, and the market is looking forward to an increase in business activity next month. The statistical position of the metal continues to improve, and it is anticipated that there will be a decrease in the visible supply at the end of January of about 1500 tons. On the other hand, American deliveries are expected to be between 3000 tons and 3500 tons, which is a rather disappointing estimate.

Copper.

Business in electrolytic copper has improved of late, although it is still well below normal. European consumers appear to think that a further advance in price is likely, and are, no doubt, supported in this view by the renewal of negotiations for the institution of the copper "code" in the United States. The movements of the dollar exchange have, of course, automatically raised the sterling price, and as the American export quotation has been stiffer at 8·27½ c. per lb., the sterling price has been £36 15s. to £37 per ton c.i.f. Europe. The American domestic price has been rather higher at 8·37½ c., but the market continues to expect that, in the event of the code being established, the quotation would be advanced to 9 c., and that a corresponding movement might take place in the export quotation. The statistics for December were not very satisfactory, as they disclosed stocks of 640,000 tons, which is an increase over November of 4500 tons. The stocks in North America totalled 523,000 tons, an increase of 2750 tons over November. The total world production in December is given as 88,500 tons, which included 12,750 tons from scrap. The output of copper in the United States in 1933, however, showed a considerable reduction compared with 1932, the totals being 336,000 tons and 462,786 tons respectively. Rather busier conditions have ruled in the London standard market this week, and prices have been firm. Speculators who, for a time, left this market alone, seem to be encouraged by the low price of the metal and the prospects of an advance to operate on a fairly extensive scale. The margin between standard and electrolytic is unusually narrow at about £3, and if the recent demand for standard copper is maintained, it may cause the electrolytic price to be further advanced.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Hematite Mixed Nos.	3 2 6	3 0 0
No. 1	3 3 0	3 0 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	3 5 0	—
MIDLANDS—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 6	—
Basic	3 10 0	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	3 6 0	—
N.W. COAST—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow; 4 0 6 „ Sheffield; 4 5 6 „ Birmingham	

(*Basic iron prices subject to a rebate of 5/–.*)

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
LANCS.—		
Crown Bars	9 0 0	
Best Bars	9 10 0	
S. YORKS.—		
Crown Bars	9 15 0	
Best Bars	10 15 0	
MIDLANDS—		
Crown Bars	8 10 0 to 9 0 0	
Marked Bars (Staffs.)	12 0 0	
Nut and Bolt Bars	6 15 0 to 7 10 0	
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. COAST—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
LONDON AND THE SOUTH—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	7 10 0	—
Plates, ¼in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ⅜in.	9 10 0	8 5 0
„ 7/16in.	9 15 0	8 10 0
„ ½in.	9 7 6	8 5 0
NORTH-EAST COAST—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 7 6	7 0 0
Plates, ¼in.	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ⅜in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ½in.	9 2 6	8 5 0
Boiler Plates, ¼in.	8 5 0	7 12 6
MIDLANDS, AND LEEDS AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 10 0	7 0 0
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ⅜in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ½in.	9 7 6	8 5 0
Boiler Plates, ¼in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
GLASGOW AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 15 0	7 0 0
Plates, ¼in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ⅜in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ½in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
SOUTH WALES AREA—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 10 0	7 0 0
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ⅜in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ½in.	9 7 6	8 5 0

IRELAND—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 10 0	8 0 0
Plates, ¼in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ⅜in.	9 10 0	9 12 6
„ 7/16in.	9 15 0	9 17 6
„ ½in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	8 15 0	8 15 0
14-G. to 20-G., d/d	10 0 0	9 0 0
21-G. to 24-G., d/d	10 5 0	9 5 0
25-G. to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/3 to 16/6.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic, Soft (25·41% C.)	6 0 0
„ Medium (0·42% to 0·60% C.)	6 17 6
„ Hard (0·61% to 0·85% C.)	7 7 6
„ „ (0·86% to 0·99% C.)	8 7 6
„ „ (1% C. and up)	8 17 6
Soft (up to 25% C.), 500 tons and up	5 5 0
100 tons	5 12 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/9 per lb.	
Ferro Tungsten	2/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 12 6	7/–
„ „ 8 p.c. to 10 p.c.	£21 12 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 10 0	9/–
„ „ „ 1 p.c. carbon	£35 12 6	10/–
„ „ „ 0·70 p.c. carbon	£37 10 0	12/6
„ „ „ carbon free	10½d. per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 0 0 to 17 10 0 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/– per lb.	

NON-FERROUS METAL.

Official Prices, January 24th.

COPPER—	
Cash	£33 16 3 to £33 17 6
Three months	£33 18 9 to £34 0 0
Electrolytic	£37 0 0 to £37 5 0
Best Selected Ingots, d/d Birmingham	£36 15 0
Sheets, Hot Rolled	£62 0 0
	Home. / Export.
Tubes, Solid Drawn (basis)	10d. / 10d.
„ Brazed (basis)	10d. / 10d.
BRASS—	
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0
	Home. / Export.
Tubes, Solid Drawn, 2/1 alloy	9d. / 9d.
„ Brazed	11d. / 11d.
TIN—	
Cash	£227 10 0 to £227 15 0
Three months	£227 7 6 to £227 10 0
LEAD	£11 15 0 to £11 17 6
SPELTER	£15 0 0 to £15 3. 9
Aluminium Ingots (British)	£100

FUELS.

SCOTLAND.

LANARKSHIRE—		Export.
(f.o.b. Grangemouth)—Navigation Unscreened		13/3 to 13/6
„ Glasgow—	Ell	14/– to 16/–
„ „	Splint	17/–
AYRSHIRE—		
(f.o.b. Ports)—Steam		13/– to 13/3
FIFESHIRE—		
(f.o.b. Methil or Burntisland)—Steam		14/6 to 14/9
Unscreened Navigation		12/6 to 13/–
LOTHIANS—		
(f.o.b. Leith)—Hartley Prime		14/– to 14/6
Secondary Steam		13/6 to 13/9

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	17/6 to 20/6
Furnace Coke	13/– to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	14/– to 15/–
„ Second	13/– to 13/3
„ Best Small	10/6 to 11/–
Unscreened	12/– to 13/6
DURHAM—	
Best Gas	14/8
Foundry Coke	17/– to 19/6

SHEFFIELD—	Inland.
Best Hand-picked Branch	27/– to 28/–
South Yorkshire Best	22/– to 24/–
South Yorkshire Seconds	17/6 to 19/6
Rough Slacks	6/– to 9/–
Nutty Slacks	7/– to 8/6
Furnace Coke (at ovens)	12/3

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to
Best Dry Large	18/9 to 19/–
Ordinaries	18/3 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/–
Foundry Coke	21/– to 36/–
Furnace Coke	18/6 to 20/–
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm	9/6 to 10/6
Steam Coals:	
Large	18/– to 20/–
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ½d. per gallon extra

French Engineering Notes.

(From our own Correspondent in Paris.)

Import Quotas.

THE British Chamber of Commerce in Paris has sent an urgent appeal to the British Government to abstain from negotiating with France until the import quotas are restored to what they were before January 1st. Germany has imposed further restrictions on imports from France as reprisals for the failure of recent negotiations which broke down because France insisted on making bargains with 75 per cent. of the former quotas, and Italy has, for the same reason, reduced the quotas of imports from France to a level that, for some products, amounts almost to total exclusion. The French reply to Germany has been to denounce the existing commercial treaty. The only effect of the new method of manipulating quotas has been to accelerate the already alarming decline of France's export trade. Other countries will not accept a system which is of too rigid a character, and which, if allowed as a basis for negotiation, would deprive trade and commerce of all liberty for expansion. The attitude of the French may be understood when it is remembered that an active industrial development took place under cover of protection in the years following the Armistice, during which period reconstruction and national works of all kinds were carried out with German reparations in collaboration with French industries. The industrial situation is now extremely precarious, and the outlook disquieting. The French fear a violent competitive effort amongst some foreign countries from which they are anxious to protect themselves, and they believe that the system of import quotas applied on a strictly reciprocal basis offers them the only safeguard. Nevertheless, they have national products that fear no competition, and these will obviously suffer, as they are now doing, from an excessive restriction of imports. The stand taken by Britain, the United States, and other countries against the reservation of quotas as a means of negotiating commercial treaties has already weakened the French line of defence. The French have had to give way in order to save their trade in national products. They begin to see that some sacrifice is inevitable, and there are now schemes for saving industries by specialising in quality production.

Railway Equipment.

The agitation for a drastic reorganisation of railway methods has been kept alive by parliamentary debates and by the Railwaymen's Union, which has presented a list of proposed reforms, comprising a unification of locomotives and signalling systems on all the railways, automatic braking of locomotives when they pass signals at danger, and the removal of regulations governing speeds, whatever may be the atmospheric conditions. As the result of what has already been learned by experts who are inquiring into the cause of the Langy disaster, the Minister of Public Works has announced his intention of asking Parliament to authorise the raising of a public loan in order to carry out an extensive programme of works. Out of a proposed expenditure of 2800 million francs, 1000 million francs will be employed for the construction of steel coaches and of "metallised" coaches—that is to say, coaches partly of wood and partly of steel, the idea being that on account of their cost and weight the all-steel coaches will be used only for express trains, while the present wooden coaches will be superseded by a composite type in which the use of steel will be expected to provide the necessary rigidity. At all the big stations the lines will be quadrupled at an estimated cost of 1800 million francs.

The "Emeraude" Disaster.

So complete was the destruction of the aeroplane "Emeraude" which crashed and burst into flames at Corbigny, that the cause of the disaster will probably never be known. There is a suggestion that the ailerons became detached. One certain fact, however, is that on returning from its record flight from Paris to Saigon, the "Emeraude" experienced trouble beyond Karachi, where it was delayed for the arrival of spare parts, and it again made an emergency landing at Lyons. This monoplane carried the Air Minister to Moscow, and to Algiers, and it represented the latest type of aircraft to be chosen for service to the Far East.

Wages.

The suppression of the surtax and the lowering of the turnover tax on imports from Britain have compelled employers in the weaving industry in the Lille district to post notices for a reduction in wages. They say that they are carrying on in the hope of getting relief from excessive charges or of being sufficiently protected by the new Tariff Bill. This statement reflects the situation of many industries that are suffering from fiscal measures which are imposed in favour of others, such as the high cost of coal resulting from import quotas and the taxing of foreign fuels, to which must now be added the proposed tax on French coal production for the creation of an unemployed relief fund. The agitation of the colliery industry is an almost irresistible factor in the present situation. Rising costs, falling trade, dear money, and the fear of a levelling down of production costs in Great Britain and the United States are causing considerable anxiety. Manufacturers are aware that their salvation lies in cheapening production, which they can only do, in present circumstances, by lowering wages, but all attempts to cut wages meet with uncompromising resistance. A representative of the employers' metallurgical unions and syndicates, Monsieur Villey, proposes to meet the difficulty by a modification of the wage bonus system. The offer of bonuses has been a great incentive to production, which must, nevertheless, be kept within bounds if the manufacturer is not to find that he is turning out more than he can sell. Monsieur Villey therefore suggests that the bonus rate should be increased proportionately up to a certain point, to be determined by the employer according to the character of the goods produced and the demand for them, and that the proportionate increase should thereafter rapidly decline. The peak at which the bonus rate should fall off would be ascertained by experience and stabilised accordingly.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

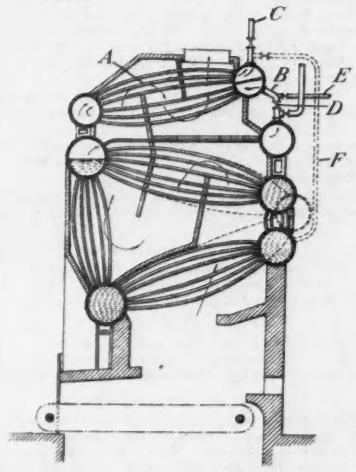
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

403,032. June 20th, 1933.—WATER-TUBE BOILERS, Miyokichi Ikeda, No. 235, Nichome, Okubo, Yodobashiku, Tokyo, Japan.

The inventor suggests that a superheater may be used alternatively as a feed-water heater if saturated steam is required.

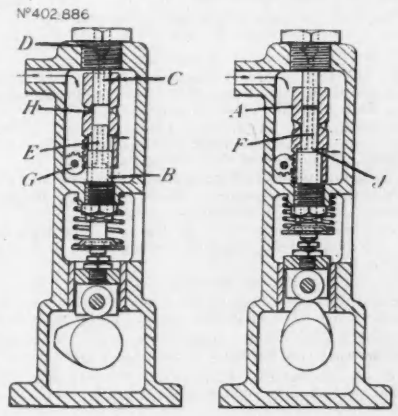


The superheater is shown at A. It is connected with the boiler steam drum by the pipe B, and delivers superheated steam at C. In the event of it being used as a feed heater, the valve D is closed, feed is supplied at E, and after passing through the heater goes by way of the pipe F to the boiler water drum.—*December 14th*, 1933.

INTERNAL COMBUSTION ENGINES.

402,886. January 30th, 1933.—FUEL INJECTION PUMPS, S. Alder, 3, Westcliffe-road South, Roker, Sunderland.

The barrel of this fuel pump is formed by the floating sleeve A, which is guided between the plugs B and C. The plug C contains the non-return delivery valve D. The plunger E has a by-pass port F, and the sleeve can be raised and lowered by the rack and pinion G. It is also pierced with inlet ports at H.

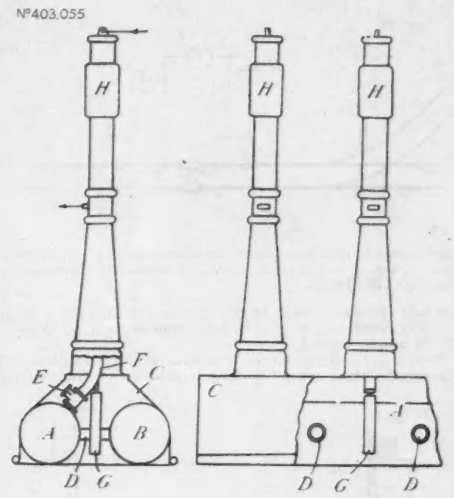


With the sleeve in the top position the fuel merely circulates through the ports until the extreme end of the pump stroke is reached. With the sleeve in a lower position a larger amount of oil is entrapped above the ports H and is injected until the port J in the plunger passes the lower guide plug B, when the delivery pressure is released and injection suddenly ceases.—*December 14th*, 1933.

SWITCHGEAR.

403,055. August 17th, 1933.—GAS BLAST ELECTRIC SWITCHES, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.*

Owing to the necessary insulation and phase spacing of high-voltage multi-pole gas-blast switches, composed of individual single-pole units mounted side by side it is difficult to combine the units on a common base without imposing too great a weight upon the latter. According to the invention a very rigid base plate is obtained without an unnecessary increase in weight by constructing it from at least two tubular supports, which at the same time serve as pressure gas containers. A and B are the longitudinally located tubular supports, held together by the common sheet metal frame C, which either rests on the ground directly or is supported on travelling rollers. The tube B is supplied from a source of pressure gas, such as a compressor, and is connected by intermediate pipes D with the tube A, which, in turn, is connected through valves E and pipes F to the individual gas blast switches. In the form of construction shown, operating cylinders G are provided for the contacts of each switch. When the switches are connected by a common driving shaft, there is, of course, nothing to prevent the use of one common operating cylinder. The individual switches H are disposed vertically and are arranged side by side in the longitudinal direction of the tubes. They may be constructed



in a known manner with single or multiple breaks, as desired.—*December 14th*, 1933.

BATTERIES AND ACCUMULATORS.

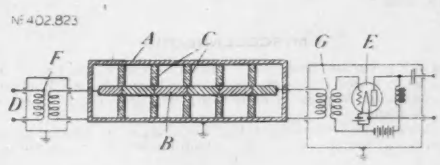
402,752. May 28th, 1932.—ELECTRIC STORAGE BATTERIES, Drumm Battery Company, Ltd., of Inchicore, Dublin, and Robert Henry Douglas Barklie, of the same address.

This invention relates to electric storage batteries or accumulators with alkaline electrolyte, and while particularly designed for batteries of the "Drumm" make, it may be applied to other alkaline accumulators. The object of the invention is to reduce as far as possible the weight of the battery for a given capacity, and according to the invention this object is achieved by using for the construction of the various cell parts magnesium or a magnesium rich alloy (that is, an alloy containing not less than 80 per cent. magnesium), the alloy being preferred on account of the improved mechanical properties. An alloy of magnesium and nickel only, however, is known to be brittle and incapable of mechanical working, and this difficulty has been overcome by the addition of small amounts of other metals, such as manganese, cadmium and zinc, thus forming ternary alloys having satisfactory toughness as well as good electrical conductivity. Examples of alloys which have been found suitable are as follows:—(1) Magnesium, 92 per cent.; nickel, 4 per cent.; and manganese, 4 per cent. (2) Magnesium, 91 per cent.; nickel, 6·5 per cent.; manganese, 2·5 per cent. (3) Magnesium, 92 per cent.; nickel, 4 per cent.; and cadmium, 4 per cent. (4) Magnesium, 97 per cent.; nickel, 1·5 per cent.; cadmium 1·5 per cent. (5) Magnesium, 99 per cent.; nickel, 0·5 per cent.; and cadmium, 0·5 per cent. (6) Magnesium, 82 per cent.; nickel, 8 per cent.; cadmium, 8 per cent.; and chromium, 2 per cent. (7) Magnesium, 96 per cent.; nickel, 2 per cent.; zinc, 2 per cent. Example (5) is preferred.—*November 28th*, 1933.

TELEGRAPHS AND TELEPHONES.

402,823. June 10th, 1932.—ELECTRICAL IMPEDANCE NETWORKS, *Standard Telephones and Cables, Ltd., of Connaught House, Aldwych, London, W.C.2.*

The attenuating device which is shown schematically is suitable for very high frequencies, and comprises an outer conducting tube A within which are series resistors B and resistors C, forming shunt paths between the junction points of the series resistors and the outer conductor. The resistors B are preferably in the form of rods, and may consist of insulating material, glass or porcelain, coated with a thin film of metal. Resistors C are of similar type in disc or plate form, and should be of such size and shape as to fill the cross section of the tube. In use the central resistors B constitute the line conductor and



the outer conductor A the return path. When the outer conductor is earthed or otherwise fixed in potential, it acts as an electrostatic shield between the resistors and other apparatus. To make the shielding more complete, the ends of the outer conductor may be partially closed, as shown. The shunt resistors C, moreover, act as electrostatic shields preventing direct capacity effects between the several stages. The diagram shows the device connected between a line D and a shielded amplifier E through shielded transformers F and G, the connections being made on one side to the outer ends of the terminal series resistors B and to the other side to the shielding conductor A. The construction of a variable attenuator is described.—*December 11th*, 1933.

TRAMWAYS AND RAILWAYS.

402,996. April 27th, 1933.—SHUNTING YARDS, Vereinigte Eisenbahn-Signalwerke G.m.b.H., of Berlin-Siemensstadt, Germany.

In shunting yards, in which the wagons are distributed automatically or semi-automatically to the individual sidings, for example, in gravity run shunting yards, insulated rails are, in general, the only means so far used to control the points for the individual tracks. The current, led through the insulated rails, is connected or short-circuited through the train axles, and the connection thus depends on the resistance of the axles. There are, however, certain wagons which have a resistance between the wheels and axle, which is altogether too high, and incorrect movement of the points may result. The object of the invention is to overcome this trouble. At the entrance to the shunting yard there is an insulated rail A connected through a conductor B with a relay C, which receives current from a source of current D, when the contact E is engaged by the axle F. The relay C is connected through a conductor G with the opposite rail H.

When the contact E is engaged by an axle F, the relay C receives current from the source D. Simultaneously, however, the relay is short-circuited through the axle F and the conductor G, so that only in the case of high resistance of the axle, when the

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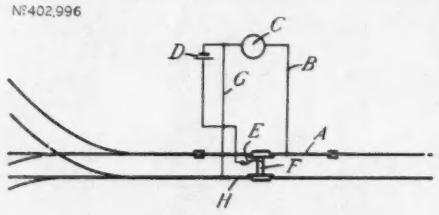

short circuit is insufficient, does the relay C operate, and thereby cause a signal to be given denoting high axle resistance.—*December 14th*, 1933.

402,287. February 28th, 1933.—PNEUMATIC TIRES FOR RAILWAY VEHICLES, Austro Daimler-Puchwerke A.G., Wiener-Neustadt, Austria.

According to this invention a pneumatic tire A is interposed between the wheel centre B and the running tire C. The running

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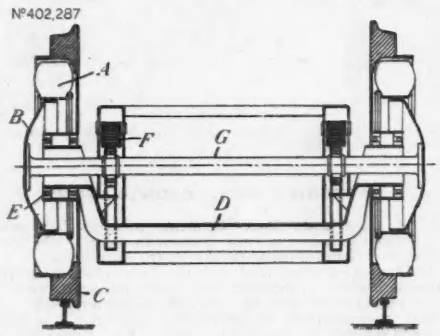

tires are kept in alignment by the bent axle D, which is connected with the wheels by the ball bearings E. The weight of the vehicle is transmitted through the springs F, the axle G, and the centres B to the inner periphery of the pneumatic tires. The driving effort is also passed through the axle G.—*November 30th*, 1933.

403,039. July 8th, 1933.—ROLLER BEARING AXLES, The Timken Roller Bearing Company, Corner of Nineteenth-street and Denber-avenue, Canton, Ohio, United States of America.

It is explained that on account of the overhang of the wheels of a railway vehicle beyond the bearings, the axle must be bent to some extent by the load, as shown by the broken lines. This

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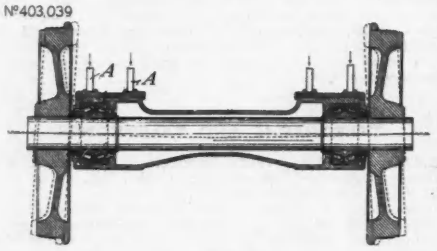

normally puts an unequal load on the opposite ends of the bearings. The inventors, however, apply the load to the bearings excentrically and deflect their casing to conform to the bending of the axle. It will be seen that the mean position of the load applied by the equalising bars A A lies inside the centre of the bearing and tends to bend the casing downwards.—*December 14th*, 1933.

MISCELLANEOUS.

403,341. August 22nd, 1933.—FILLING THE FUEL TANKS OF BUOYS AND BEACONS, Naamlooze Vennootschap Machinerieen-en Apparaten-Fabrieken, 30, Croeselaan, Utrecht, Holland.

This is a device for facilitating the filling of navigation buoys with liquid propane gas—a gas which has a low vapour tension

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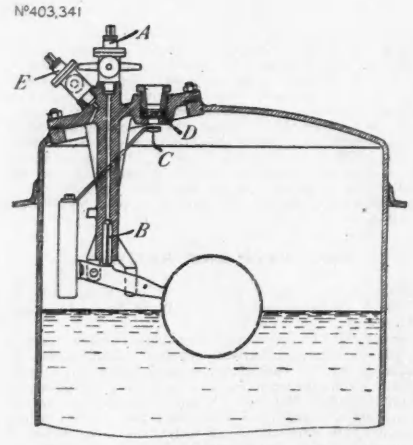


at the normal temperature of sea water. The container is filled through the stop cock A and ball cock B, up to the correct level, when the ball cock shuts off the supply. At the same time the red disc C is brought beneath the window D so that the attendant knows that the charge is completed. The outlet valve is shown at E.—*December 21st*, 1933.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND CENTRE.—Grand Hotel, Harrogate. Dance, 8 p.m. to 2 a.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. "Automatic Combustion Control of Boiler Plants," Messrs. J. L. Hodsgon and L. L. Robinson. 6 p.m.

INST. OF STRUCTURAL ENGINEERS.—At James Watt Memorial Inst., Birmingham. "Reinforced Concrete Bins and Silos," Mr. A. E. Jennens. 6.30 p.m.

INST. OF STRUCTURAL ENGINEERS: LANCASHIRE AND CHESHIRE BRANCH.—Midland Hotel, Manchester. Annual Dinner.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Air for Combustion with special reference to Air Heaters," Mr. A. E. Bingham. 7.30 p.m.

N.E. COAST INST. OF ENGINEERS AND SHIPBUILDERS.—Mining Inst., Newcastle-upon-Tyne. "The Possibilities of Applying Improvements Effected in Land Power Plant to Ship Propelling Machinery," Messrs. W. T. Bottomley, E. W. Corlett, and F. Piercy. 6 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1.—Discourse, "Dust and Smoke," Dr. R. Whytlaw-Gray, F.R.S. 9 p.m.

TEES-SIDE INDUSTRIAL SAFETY COMMITTEE.—Cleveland Technical Inst., Middlesbrough. "Workers and Safety First," Mr. R. Dennison. 7.30 p.m.

UNIVERSITY OF LONDON.—King's College, Strand, W.C.2. "Apparatus for Power Factor Correction," Mr. D. B. Hoseason. 5.30 p.m.

SATURDAY, JANUARY 27TH.

INST. OF ELECTRICAL ENGINEERS: N.E. STUDENTS.—Visit to Rope Works of Messrs. R. Hood Haggie and Son, Willington, Quay-on-Tyne. 2.30 p.m.

MONDAY, JANUARY 29TH.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN CENTRE.—At the Rendez-Vous Restaurant, Pilgrim-street, Newcastle-upon-Tyne. Informal meeting. Discussion, "Load Building." 7 p.m.

TUESDAY, JANUARY 30TH.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W. 1. Further discussion on "Hammer-blow Impact on the Main Girders of Railway Bridges," Mr. R. W. Foxlee and Mr. E. H. Greet; "Moving Load Stresses in Short-span Railway Bridges," Mr. W. E. Gelson. 6 p.m.

INST. OF PRODUCTION ENGINEERS: YORKSHIRE SECTION.—Hotel Metropole, Leeds. "Welding," Mr. J. E. Kennards. 7.30 p.m.

INST. OF TRANSPORT.—London, informal meeting. Discussion, "Traffic Light Control Signals," opener, Mr. J. S. Pool.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. "Ternary Systems," Mr. E. Gregory. 7.30 p.m.

WEDNESDAY, JANUARY 31ST.

INST. OF CHEMICAL ENGINEERS.—At Chemical Soc., Burlington House, Piccadilly, W.1. "Washing of Gas," Messrs. H. Hollings and L. Silver; "Multi-stage Washers," Mr. L. Silver. 6 p.m.

INST. OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOC.—Midland Hotel, Manchester. Annual dinner. 6.30 p.m. for 7 p.m.

MANCHESTER METALLURGICAL SOC.—Joint meeting with Manchester Assoc. of Engineers, at College of Technology, Manchester. "Alloy Steels," Mr. J. A. Jones. 7 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C. "The Pooling of Water Supplies," Mr. Alan E. L. Chorlton. 8 p.m.

THURSDAY, FEBRUARY 1ST.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, W.C.2. "Research in the British Post Office" (to be illustrated by a talking film), Mr. B. S. Cohen. 6 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—At James Watt Memorial Inst., Birmingham. Open discussion of the Metallurgical Inspection of Engineering Materials. 7 p.m.

MANCHESTER ASSOC. OF ENGINEERS: STUDENTS' SECTION.—At Y.M.C.A., Peter-street, Manchester. "Mechanical Granaries," Mr. C. P. Kininmouth. 7.30 p.m.

ROYAL AERONAUTICAL SOC.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "Engine Cowlings." Mr. J. D. North. 6.30 p.m.

FRIDAY, FEBRUARY 2ND.

FARADAY HOUSE OLD STUDENTS' ASSOC.—At Midland Hotel, St. Pancras, N.1. Annual dinner, dance. 7.30 p.m. to 1 a.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND CENTRE.—Royal Victoria Hotel, Sheffield. Dance, 7.30 p.m. to 1 a.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting, discussion introduced by Mr. H. G. Mitchell on Production. 7 p.m.

INST. OF MINING ENGINEERS.—At Rooms of Geological Soc., Burlington House, Piccadilly, W.1. Annual general meeting. Presentation of Medal to Mr. H. Eustace Mitton. Discussion, "Sheathed Explosives," Messrs. C. A. Naylor and R. V. Wheeler; "Safety Lamps for Use by Underground Officials," Captain C. B. Platt; "*Draft* Standard Specification for the Testing of Mine Fans." 11.15 a.m. Luncheon, 1 p.m. Meeting resumed, 2.15 p.m.

INST. OF PRODUCTION ENGINEERS: LONDON SECTION.—83, Pall Mall, S.W.1. "Control of Quality in Hardening and Heat-treatment Processes," Mr. H. H. Beeny. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Salvage and Disposal of Town Refuse," Mr. A. E. Clouds. 7.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse by Lord Conway of Allington. 9 p.m.

UNIVERSITY OF LONDON.—King's College, Strand, W.C.2. "Apparatus for Power Factor Correction," Mr. D. B. Hoseason. 5.30 p.m.

SATURDAY, FEBRUARY 3RD.

INST. OF CIVIL ENGINEERS.—Students' visit to L.P.T.B. railway works at Acton. Morning visit.

MONDAY, FEBRUARY 5TH.

ENGINEERS' GERMAN CIRCLE.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Neuere Grosswerkzeugmaschinen und ihre Verwendung (Modern Heavy Machine Tools and their Use)," Herr Dr.-Ingenieure H. Haake, Professor an den Technischen Staatslehranstalten, Hamburg. 6 p.m.

SOC. OF CHEMICAL INDUSTRY.—At Chemical Soc., Burlington House, W.1. "Recovery of Benzol by Activated Carbon," Messrs. H. Hollings and S. Hay. 8 p.m.

TUESDAY, FEBRUARY 6TH.

ELECTRO-DEPOSITORS' TECHNICAL SOC.: MIDLANDS CENTRE.—James Watt Memorial Inst., Birmingham. Mr. E. J. Dobles will open discussion, "Nickel Plating Troubles." 7.30 p.m.

STEPHENSON LOCOMOTIVE SOC.—King's Cross Station, N.1. "Single-wheeled Engines," Mr. A. G. Williamson. 6.30 p.m.

WEDNESDAY, FEBRUARY 7TH.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C. "The Human Element in Industry," Mr. Robert R. Hyde. 8 p.m.

SOC. OF GLASS TECHNOLOGY: LONDON SECTION.—Visit to Scrub's-lane depôt of United Dairies, Ltd. 7.30 p.m.

THURSDAY, FEBRUARY 8TH.

INST. OF ELECTRICAL ENGINEERS.—Grosvenor House, Park-lane, W.1. Annual dinner and reunion. 7 p.m.

INST. OF MARINE ENGINEERS: JUNIORS.—The Minories, E.C.3. Debate, "Coal *v.* Oil Fuel for Steam Raising." 7 p.m.

INST. OF METALS: LONDON LOCAL SECTION.—At 83, Pall Mall, S.W.1. "Electric Annealing and Heat-treatment Furnaces," Mr. A. G. Lobley. 7.30 p.m.

ROYAL AERONAUTICAL SOC.—Meeting postponed.

FRIDAY, FEBRUARY 9TH.

INST. OF METALS: SHEFFIELD LOCAL SECTION.—In Applied Science Dept., The University, Sheffield. "Recovery and Refining of Precious Metals," Mr. H. G. Dale. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Honorary Member's Lecture, "Thunder Storms, Magnetic Storms, and Wireless Transmission," Professor E. V. Appleton, F.R.S. 7.30 p.m.

MONDAY, FEBRUARY 12TH.

INST. OF METALS: SCOTTISH LOCAL SECTION.—At 39, Elmbank-crescent, Glasgow. "Combustion Efficiency," Mr. J. A. C. Edmiston. 7.30 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2.—Thomas Gray Lecture, "Deep Diving and Under-water Rescue," Sir Robert H. Davis. 8 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

HORDERN, MASON AND EDWARDS, Ltd., request us to say that they are now in occupation of their new works at Erdington, Birmingham.

JOHN M. HENDERSON AND CO., Ltd., King's Works, Aberdeen, are now the principal agents for the "Wylie" safe load indicator and sound signal for locomotive cranes.

THE office of the Association of Engineers, 20, Strand-road, Calcutta, has been removed to 2, Royal Exchange-place (third floor), Calcutta, which is a much more commodious and suitable building.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

BRITISH DARDELET THREADLOCK, Ltd., Chase-road, London, N.W.10, has received orders for 30,000 Dardelet fish-bolts for the Buenos Aires and Pacific Railway, and also a large order for the same material for the Argentine State Railways.

SAML. DENISON AND SON, Ltd., Hunslet Foundry, Leeds, have received an order for a railway truck weighbridge for a cement works in China. This machine is to be fitted with "Denison" patented equilibrium control tape and ticket apparatus.

THE MOTHERWELL BRIDGE AND ENGINEERING COMPANY, Ltd., of Motherwell, has received a contract for the supply of two complete road bridges for the Union of South Africa Public Works Department. These bridges are the Orange River Bridge, 1050ft. in length, comprising six side spans, each 140ft. by 15ft. wide, and one centre span of 200ft. by 30ft. wide; and the Umlaas River Bridge, 410ft. in length, comprising two spans, each 200ft. by 30ft. wide. The total tonnage of steel work involved in these two bridges is about 1500 tons.

THE ENGLISH ELECTRIC COMPANY has received an order from the Leather Cloth Company, Ltd., London, for a turbo-alternator set, comprising a 1000 kW geared impulse pass-out turbine, running at 6000 r.p.m., and having a maximum continuous rating of 1000 kW. The set will generate power and supply process steam for the works up to 15,000 lb. of steam per hour at a pressure of 30 lb. per square inch gauge. The alternator will generate power at 500 volts, 50 cycles, three-phase. The order also includes the necessary switchgear for the control of this unit.

BRIMS AND CO., Ltd., Pandon Buildings, Newcastle-on-Tyne, have received an important foundation contract for the petrol from coal plant which is to be erected by Imperial Chemical Industries, Ltd., Billingham-on-Tees, and the work is now in full swing; 2000 reinforced concrete piles are being driven, the majority of which are the special Vibro Cast-in-Situ piles, for the construction of which Brims and Co., Ltd., hold a licence from the British Steel Piling Company, of London. It is expected that the foundations will be completed in the early spring. Reinforced concrete capping will be constructed by the contractors on top of the piles in order to carry the enormous weight of the special cranes and other heavy plant required for the new process. This work is at present giving employment to about 200 men.

CALENDARS, DIARIES, &c.

BRITISH JEFFREY-DIAMOND, Ltd., Wakefield.—Wall calendar.

CHEMICAL TRADE JOURNAL AND CHEMICAL ENGINEER, 265, Strand, W.C.2.—Wall calendar.

CROMPTON PARKINSON, Ltd.—Wall calendar.

HALL, B. J., AND CO., Ltd., Shell Corner, Kingsway, W.C.2.—Wall calendar.

JAPANESE GOVERNMENT RAILWAYS, BOARD OF TOURIST INDUSTRY, Tokyo.—Wall calendar.

PECKETT AND SONS, Ltd., Bristol.—Wall calendar.

RANSOMES AND RAPIER, Ltd., Ipswich.—Art wall calendar.

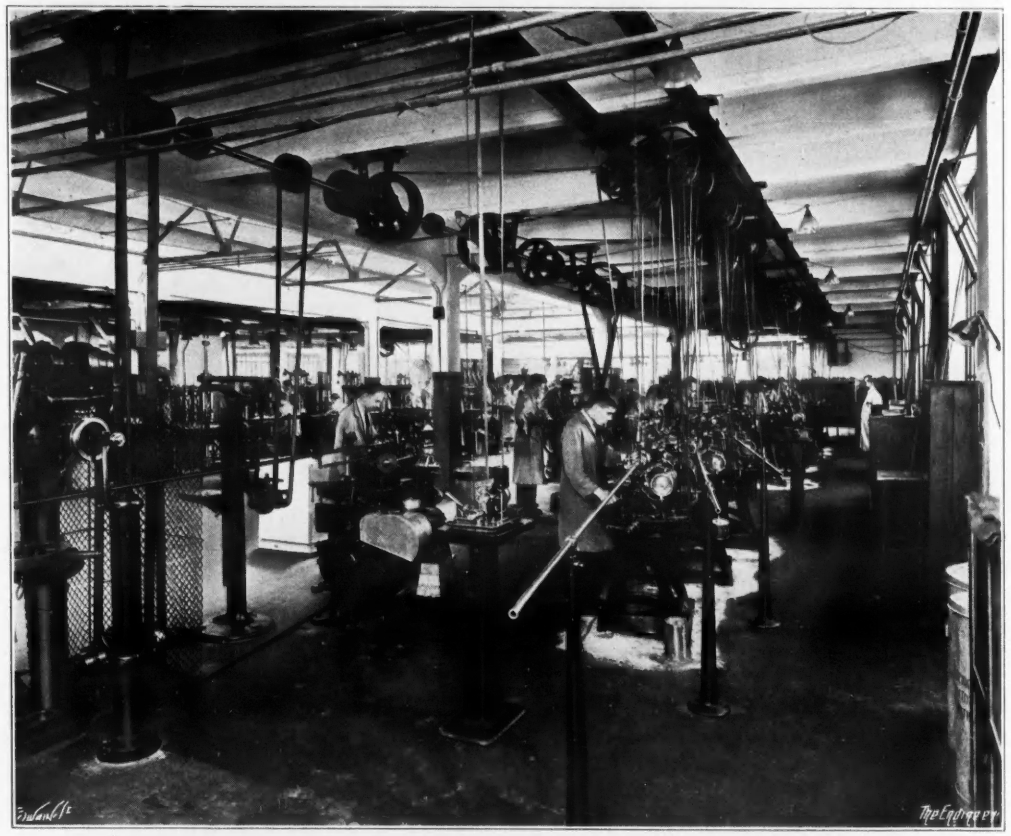
SKEFKO BALL BEARING COMPANY, Ltd., Luton.—Wall calendar.

SOUTH LANCASHIRE TRANSPORT COMPANY AND LANCASHIRE UNITED TRANSPORT AND POWER COMPANY, Ltd., Atherton, Lancs.—Wall calendar.

WELIN-MACLACHLAN DAVITS, Ltd., London.—Refill for desk calendar.

WELLINGTON PRESS, 132–5, Long Acre, W.C.2.—Wall calendar.

THE WORKS OF THE BRITISH TABULATING MACHINE COMPANY, LTD., LETCHWORTH

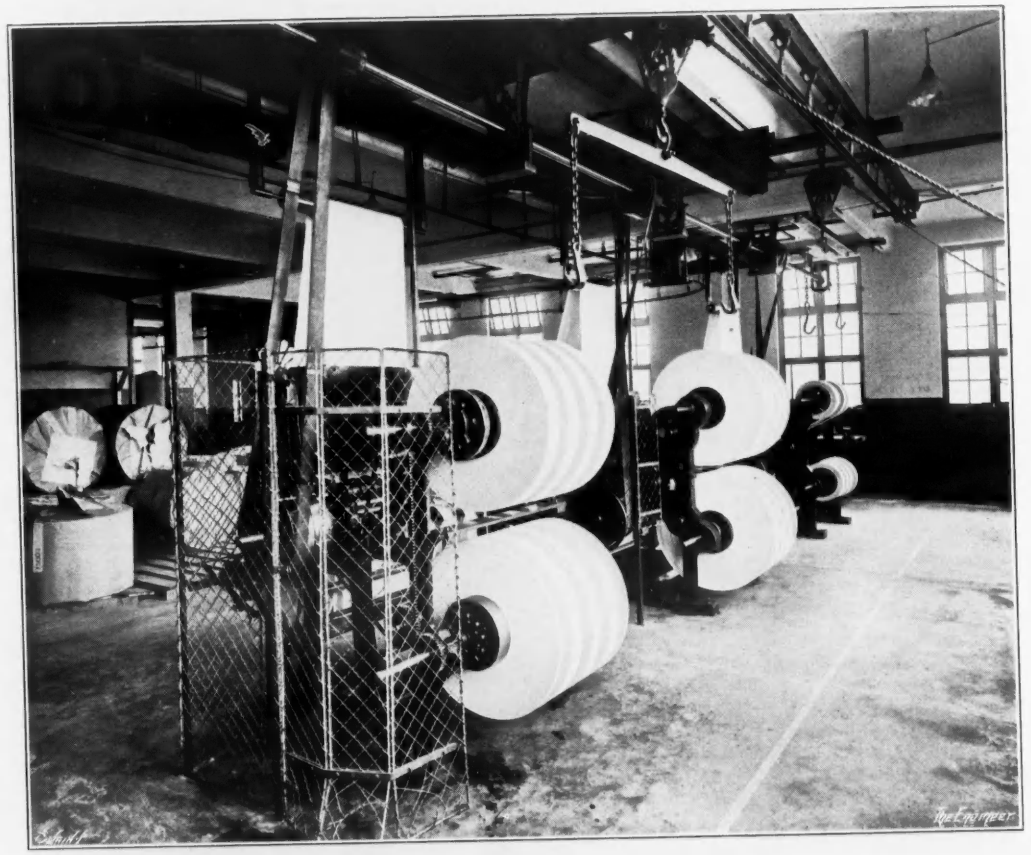


No. 1 Machine Shop

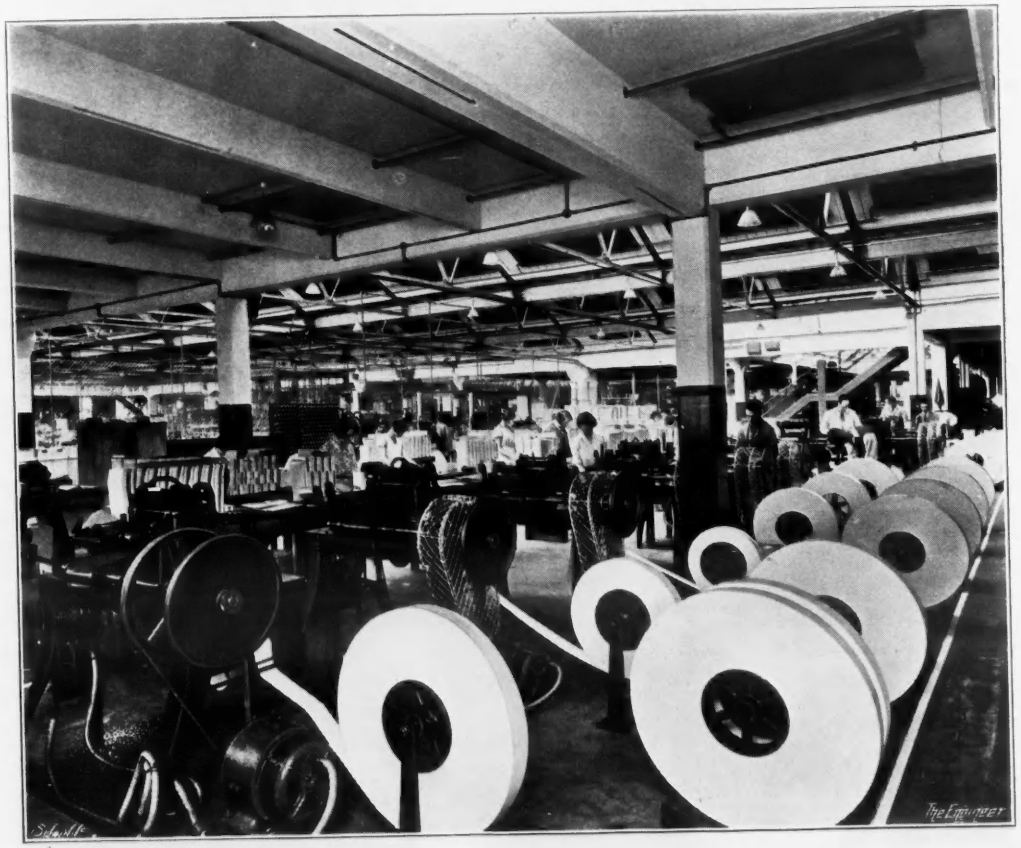
No. 2 Machine Shop

FINAL ASSEMBLY DEPARTMENT

TOOL ROOM



PAPER SLITTING DEPARTMENT



CARD PRINTING DEPARTMENT

UNIV. OF WASH.

A Seven-Day Journal

Kitson and Co., Ltd.

MANY of our readers will hear with great regret that, owing to the difficulties caused by the depression in the locomotive-building industry, the old and honoured firm of Kitson and Co., Ltd., of Leeds, has found it desirable to appoint a receiver for the debenture holders. None of the debentures are held as a public issue, and we understand that Sir Leonard J. Coates, who has consented to act as receiver, is examining the possibility of continuing the company's business with a view to reconstruction, recognising that there is already a certain revival in the locomotive trade, and that the new lines of development taken by the company in the construction of agricultural tractors and special types of metal presses hold out a promise of a successful future. Airedale Foundry was started in 1838, and the long history of this private company is interesting, not only because large undertakings of a general engineering character were carried out in earlier days, but particularly because Kitson locomotives have been sent to all parts of the world, with the exception of North America, and some of them, now of a great age, are still running.

The Steel Reorganisation Scheme.

UNUSUAL efforts are being made by those in favour of the scheme for the reorganisation of the steel industry, to which frequent reference has been made in our columns, to secure its adoption at the meeting of the National Federation of Iron and Steel Manufacturers, at which it will be considered towards the end of February. At present the scheme is before the members of the industry, and a considerable amount of propaganda is appearing in the daily Press, including unfounded statements that the Government contemplates legislation to make the scheme compulsory. Within the last few days a long letter has been circulated from the offices of the Import Duties Advisory Committee supporting the scheme. After outlining the course of events from the time the Government granted the industry protection on condition that a scheme of reorganisation was prepared, the letter states that the present modified scheme is in essence a piece of machinery presenting great possibilities of usefulness to the industry and the nation at large. The letter quotes from the National Committee's memorandum that the scheme's "ultimate success will entirely depend upon the vigour and single-mindedness with which that machinery is used." It is understood by the industry that the Advisory Committee favours the setting up of the machinery at as early date as possible. It points out that among other considerations the additional duties upon iron and steel products are due to expire on October 25th next, and that in the absence of fresh recommendations from the Committee and new legislation, the duties would automatically end. In view of this, the Committee is anxious to submit recommendations to the Government in time for its full consideration. The letter expresses the hope of the Committee that the Federation at its meeting in February will come to a "definite decision to proceed forthwith to put the scheme into operation." The letter ends with an expression of the belief that when the new central organisation has been constituted, it will be possible to concentrate upon the organisation of production and distribution in the many sections of the industry, so that it can meet the requirements of consumers in the home market and promote recovery in the export trade.

The Pooling of Water Supplies.

IN the course of a paper on "The Pooling of Water Supplies," read before the Royal Society of Arts on Wednesday evening, January 31st, Mr. Alan E. L. Chorlton, M. Inst. C.E., the President of the Institution of Mechanical Engineres, dealt with the modern development of water supply by separate undertakings. This system, he pointed out, had resulted in over 1100 distinct undertakings, which, nevertheless, had left some six million people without a piped supply. He went on to describe the so-called "water grid" system of pooling supplies, and advocated the construction of three special storage reservoirs, constructed by the Government, for abnormal times, one in the Lake District, one in the East Midlands supplied by the river Ouse, and one in the Thames Valley supplied by the flood water of that river. We had no accurate knowledge of our total supplies, Mr. Chorlton said, nor any uniform control of their allocations. He suggested that a special organisation be set up to deal with the whole question of water supply, as had been recommended repeatedly by Royal Commissions, with powers to enforce its decisions; also that a survey be made of the country to determine the total resources and thereafter their allocation. A large public company might be necessary in order to accelerate the work, and to provide the finance and special equipment. Certain mains connecting distant areas might be put in, which would pass through country districts. A possible future policy would be to press the use of water more strongly as of great advantage to health; its use would increase, and if sold as electricity, gas, &c., a large revenue would ultimately arise, also a very great deal of employment. The sale of water might become one of the big industries of the country, as electricity had, and would thus aid in solving the unemployment problem. In our total rainfall we had an ample supply to allow of such a policy.

The Late Sir William B. Hardy.

ENGINEERS no less than scientists have suffered a loss in the death of Sir William Bate Hardy, which took place in Cambridge last week. Sir William was sixty-nine years of age and had been nominated as this year's President of the British Association. He was a prominent figure in the Cambridge School of Physiology, and his studies in biology were marked by pioneer work in the investigation of colloids. This work led Sir William to investigate modern theories of lubrication, and he came to be looked upon as one of the standard authorities on boundary conditions in lubrication. He contributed an article on this subject to the "Dictionary of Applied Physics," edited by Sir Richard Glazebrook. He also took a prominent part in the discussion of lubrication problems and was a frequent visitor and speaker at meetings of scientific societies and technical institutions when questions affecting lubrication were under discussion. Sir William was a fellow of the Royal Society and an LL.D. of the universities of Aberdeen and Edinburgh, and was knighted in 1925. Four years ago he was President of the British Association of Refrigeration. His work in connection with the Food Investigation Section of the Department of Scientific and Industrial Research, of which he was Director, brought him into close touch with a wide circle of engineers.

British Goods and Crown Colonies.

AT a meeting of the Empire Committee of the Federation of British Industries, held last week, the Committee placed on record the great and immediate importance it attaches to the institution of a full system of imperial preference between the United Kingdom and the Colonial Empire. The entry of products from the Colonies into the United Kingdom is, it points out, with the exception of products upon which excise duty is levied, free, and a preference is thus given to the Colonies in the case of all articles which are subject to duty when coming from foreign countries. The Committee is aware that certain parts of the Colonial Empire are subject to treaties, the provisions of which make it a matter of difficulty for preferential treatment to be granted to United Kingdom products, at any rate until these treaties have been denounced or re-negotiated. There are, however, many Colonies which are free from all treaty restrictions. In the case of such Colonies, the Committee recommends that immediate action should be taken to introduce an effective measure of preference for British goods. It suggests that as a temporary measure a system of preference should be introduced in Crown Colonies in favour of United Kingdom goods, by which the minimum measure of preference granted by each Crown Colony as against foreign goods should be the measure of protection granted in the home market by the British tariff, in respect of those goods imported from foreign countries, but in those Colonies in which preferences in excess of this minimum are already in force, such preferences should be maintained. A recommendation is also made that since the measure of protection suggested above may not in all cases be adequate, an immediate study be made, industry by industry, of the imports into the various "free" Crown Colonies, with a view to ascertaining the measure of permanent preference which would be necessary in each case, in order that British goods could compete satisfactorily with those of foreign countries.

Tees-side Industrial Safety Committee.

THE Tees-side Industrial Safety Committee, the report of which for 1933 has just been issued, consists of representatives of fourteen firms on Tees-side with twenty-one works, employing in December, 1933, 23,184 workpeople (compared with 18,425 in December, 1932). So far as the works controlled by the members of the Committee are concerned, the number of accidents in relation to man hours worked shows a progressive decrease since the formation of the Committee in March, 1931. During the year 1933 rather over a quarter of a million hours' work, or more than 112 working years on the basis of eight hours' work per day, were lost through accidents at the works covered by the report, and as the actual man hours worked amounted to over 50 millions, the ratio of hours lost to hours worked was approximately 5 in 1000, as against 7½ per 1000 in 1930, before the Committee was set up. The wages lost by workers amounted approximately to £17,000. Had the accident ratio been as high as in 1930, however, the hours lost would have amounted to 378,000, or 157 working years, and the wages loss to approximately £24,000. The working time saved in 1933 on this basis, as against 1930, thus amounts to 45 working years, representing about £7000 in wages. On the same basis the saving in 1931 as against 1930 was 15 working years or £2000 in wages; in 1932, 30 working years or £5000 in wages. For the three years, 1931–33, it is estimated that the saving in loss of time amounts to 90 working years of eight hours per day, representing about £14,000 more in wages which has been received by employees.

Salvage Operations at Scapa Flow.

THE salvage work on the raising of the ex-German battle fleet, which for many years was carried out by Cox and Danks, Ltd., is to be continued by Metal Industries, Ltd., of 145, St. Vincent-street, Glasgow. Some of the staff has been retained in order to preserve continuity of operation, and the steamer "Bertha," which formerly belonged to the Southern Railway Company, Ltd., has been reconditioned at the yard of the Grangemouth Dock Company, Ltd., and refitted for salvage work. She recently underwent successful trials, and is now at the firm's Rosyth ship-breaking department, and will shortly leave for Lyness in Scapa Flow. The alterations to the ship comprise the fitting of heavy deck machinery, including sheer legs and cables designed to lift weights up to about 25 tons. The last ship raised by Cox and Danks, Ltd., was the "Von der Tann," and it is expected that the work of recovering some of the ships which lie in deeper water will be begun by Metal Industries, Ltd., before very long.

New G.W.R. Chairman.

ON Friday last, January 26th, the Right Honourable Sir Robert Horne was elected chairman of the Great Western Railway Company, in succession to Viscount Churchill, who died recently. Sir Robert, who has been a director of the company since 1923, will bring to his task an acute and able mind, with an unrivalled experience of industrial and transport undertakings. He is a director of the Suez Canal Company, the Peninsular and Oriental Steam Navigation Company, Lloyd's Bank, and several industrial, mining, and smelting undertakings. Born in 1871 at Slamannan, he received his education at Watson's College, Edinburgh, and the University of Glasgow. After spending some years as a lecturer and examiner in philosophy, Sir Robert was called to the Scottish Bar in 1896, and fourteen years later was appointed King's Counsel. During the war he was Assistant Inspector-General of Transportation and Director of Materials and Priority at the Admiralty in 1917, and the following year became Director of the Admiralty Labour Department and Third Civil Lord. He was appointed Knight Commander of the Order of the British Empire in 1918, and was promoted Knight Grand Cross two years later. After the war Sir Robert held high political office, and was successively Minister of Labour 1919, President of the Board of Trade 1920–21, and Chancellor of the Exchequer 1921–22. Since that time he has interested himself in the work of industrial companies, some of which we have referred to above. It is understood that Sir Robert Horne, who has represented the Hillhead Division of Glasgow since 1918, will not resign his seat in the House of Commons.

The Lympne-St. Inglevert Micro-Ray Link.

ON Friday, January 26th, Sir Philip Sassoon, the Under-Secretary of State for Air, officially inaugurated the new micro-ray radio communication service between the aerodromes of Lympne and St. Inglevert, a distance of 56 kiloms. This link has been established by the co-operation of the British and French Air Ministries and will be utilised for notifying the arrival and departure of aircraft crossing the Channel. Messages will be transmitted at a rate of sixty to seventy words per minute. With the earlier and much slower telephone system aeroplanes have been known to arrive before the message announcing their departure from the other side of the Channel has been received. The Lympne equipment was designed and supplied by Standard Telephones and Cables, Ltd., of London, and that at St. Inglevert was built by its associated company, Le Matériel Telephonique, of Paris. The equipment is the direct outcome of the successful tests made in March, 1931, between Dover and Calais, which were described in THE ENGINEER of April 10th of that year. A wave length of 17 cm. for transmission and 17½ cm. for reception is employed, the slight staggering enabling duplex working to take place simultaneously by teleprinter or telephone. The micro-rays are led to a transmitting aerial less than an inch long and are concentrated by two reflectors into a fine pencil of invisible rays, which is directed towards the receiving station. The main reflectors are over 10ft. in diameter and they are placed 43ft. high on the hangar roof at Lympne and on 66ft. steel towers at St. Inglevert. Whilst Morse or radiotelephony can be used, the normal service is carried on by Creed teleprinters. It is possible that at a later date London and Paris may be linked by telegraph or telephone *viâ* the micro-ray stations referred to.

The Development of the Parsons Steam Turbine.

No. V.

(*Continued from page 90, January 26th.*)

THE ELBERFELD TURBINES (*continued.*)

THE importance of the Elberfeld turbines as a landmark in design makes it convenient to deal with some of their features in detail, so as to present a true picture of the most advanced practice in the year 1900. To this end reference letters have been given in Fig. 31 (*ante*), and the parts referred to are shown to a larger scale in Fig. 32. Taking them in alphabetical order, Fig. 32A represents the flexible coupling used between the high and low-pressure cylinders, and also between the latter and the armature of the alternator. The muff-coupling previously used had reached the limit of its capacity, and the new design of flexible coupling, although long since discarded in favour of the Parsons claw-type now almost universally adopted, was as ingenious as it was effective for the purpose in view. The opposing shaft ends were flanged, each of the flanges having six bushed holes. Between the shaft ends was a double-flanged distance piece carrying half a dozen stout pins, the projecting ends of which engaged with the bushed holes in the shaft flanges. The arrangement allowed for a certain amount of axial play, or rather it might be said that it imposed no longitudinal constraint on either of the shafts, so that each might adopt its best position. A reasonable want of alignment of the shaft was also permitted. For the conditions under which it worked the coupling was entirely suitable, but the torque which such a device could transmit was limited by the pressure and consequent wear at the driving ends of the pins. For this reason it has given way to the modern design.

The bearings, which were originally made of bronze containing 16 parts of copper to 2·75 parts of tin, proved troublesome, apparently on account of the high speed of the journals. The surface speed of the latter was 39·5 feet per second, which was higher than anything previously attempted. It was decided, therefore, to use white metal linings, and someone brought forward a proposed formulæ for making the white metal without mentioning its source. This was tried and found so satisfactory that its use became standard practice in all the larger machines and the composition was kept secret. It was not realised for quite a long time afterwards that the mixture used was already well known under the name of Babbitt metal, consisting of 10 parts of tin to 1 part of copper and 1 of antimony.

Fig. 32B shows the H.P. end of the H.P. turbine rotor, and illustrates the method of attachment of the tube, of which the rotor was formed to the shaft. A steel collar shrunk on the shaft supported the end of the tube, and screws between the two last dummy pistons fastened the tube to the collar. The gland is shown in the same figure, and its remarkable resemblance to present-day practice will be noticed. We see the labyrinth principle fully developed, with the admission of steam near the end to prevent air leakage inwards and to show by its escape that the air-tightness of the gland was complete.

The other end of the H.P. turbine rotor is shown in Fig. 32C. The attachment of the tube to the shaft was by means of a cast iron ring shrunk on the shaft and fitting well into the interior of the tube. No provision was made for preventing endwise motion; indeed, the design was such as to facilitate the accommodation of the rotor to any differences of temperature between the tube and the shaft, another instance of the foresight of the designer. The L.P. drum was fixed to its shaft at each end by a spider, as shown in detail in Fig. 32D. Here no provision for expansion was necessary, as the smaller temperature differences and shorter length of the drum reduced the expansion to a negligible amount, which could easily be taken care of by the flexibility of the spiders.

The double-beat governor valve with its relay cylinder and piston are illustrated in Fig. 32E, and the details show much similarity to present-day practice. The operation, however, was very different, for the control of the turbine was effected by "gust-governing," which, as has been mentioned previously, has long been abandoned. It characterised Parsons turbines for many years, and ensured great sensitiveness of control, for the governor mechanism, being always in motion, was continuously "alive" and therefore ready to respond instantly to the slightest change of speed of the turbine. No sticking could take place, however long the machine had been running without change of load. As regards its effect upon the efficiency of the turbine, the admission of the steam in gusts, although possibly inferior, theoretically, in efficiency to continuous throttling, gave quite as good an economy in practice. One reason why gust governing was discarded was the irregular turning moment given to the alternator. To secure the best results when running in parallel with other machines the number of gusts per minute had to be inconveniently great. In the earlier machines about 160 to 180 gusts per minute were allowed, but the number had to be increased to 350 or 400 per minute to avoid any appreciable cyclic irregularity in the comparatively small machines of those days. Mechanical difficulties were thus encountered, but more significant was the fact that the nature of the admission of the steam was approaching more and more to that of the continuous blast obtained with throttle governing. Other considerations were the skilled adjustment necessary to make the gear satisfactory in the first place, and its tendency to make a hissing noise when the plunger became worn. It was an admirable gear when operated by steam at moderate pressure and temperature, but became unsuitable as the severity of steam conditions increased. It was, however, universally employed from 1892 till 1919 or 1920, when it was gradually displaced by the modern Parsons oil-operated type of relay. Many engineers regretted its disuse and held that it was the best governor gear on the market.

In the same casting as the main governor valve was the emergency valve shown in Fig. 32F, through which the steam had to pass on its way to the interior of the turbine. This valve, shown in its closed position, was normally held open by the hinged catch engaging with the finger on the end of the lever. In the case of excess speed or inadequate pressure of the lubricating oil, the catch was partially rotated, causing the instantaneous closing of the valve.

In Fig. 32G are given details of the worm gear and thrust block at the end of the H.P. shaft, and here, again, is the prototype of modern arrangements. The internal axial forces of the turbine being practically balanced by the dummy piston, the duty of the thrust block was merely to take care of any residual force, and to locate the axial position of the rotor. The worm wheel carried a spur wheel gearing into a pinion above, from which the reciprocating motion for the governor pilot valve was obtained by the crank pin and connecting-rod attached to the pinion. Another crank pin driven directly from the worm wheel operated the lower connecting-rod, which drove the air pump and oil pump in the basement. The construction of these pumps is shown in Fig. 32H. The vapour and condensate entered by the large branch on the right and passed out through the foot valves, bucket valves, and head valves of the air pump cylinder. Here the water came under the action of a force pump, which relieved the air pump of the duty of discharging it against any pressure. The force pump was constituted by means of a packed plunger on the same spindle as the air pump bucket and reciprocating with it. The air pump head valves formed the foot valves for the force pump. Moreover, the upward motion of the plunger created a partial vacuum above these valves, thus assisting their opening, and enabling the air pump to work with a very high volumetric efficiency. The ingenuity of the idea will be appreciated by all who like to see a mechanical problem neatly solved, though the pump has long since gone the way of all mechanical air pumps for turbine work. The valves employed were flexible rubber discs, common for that purpose in air pumps of the time.

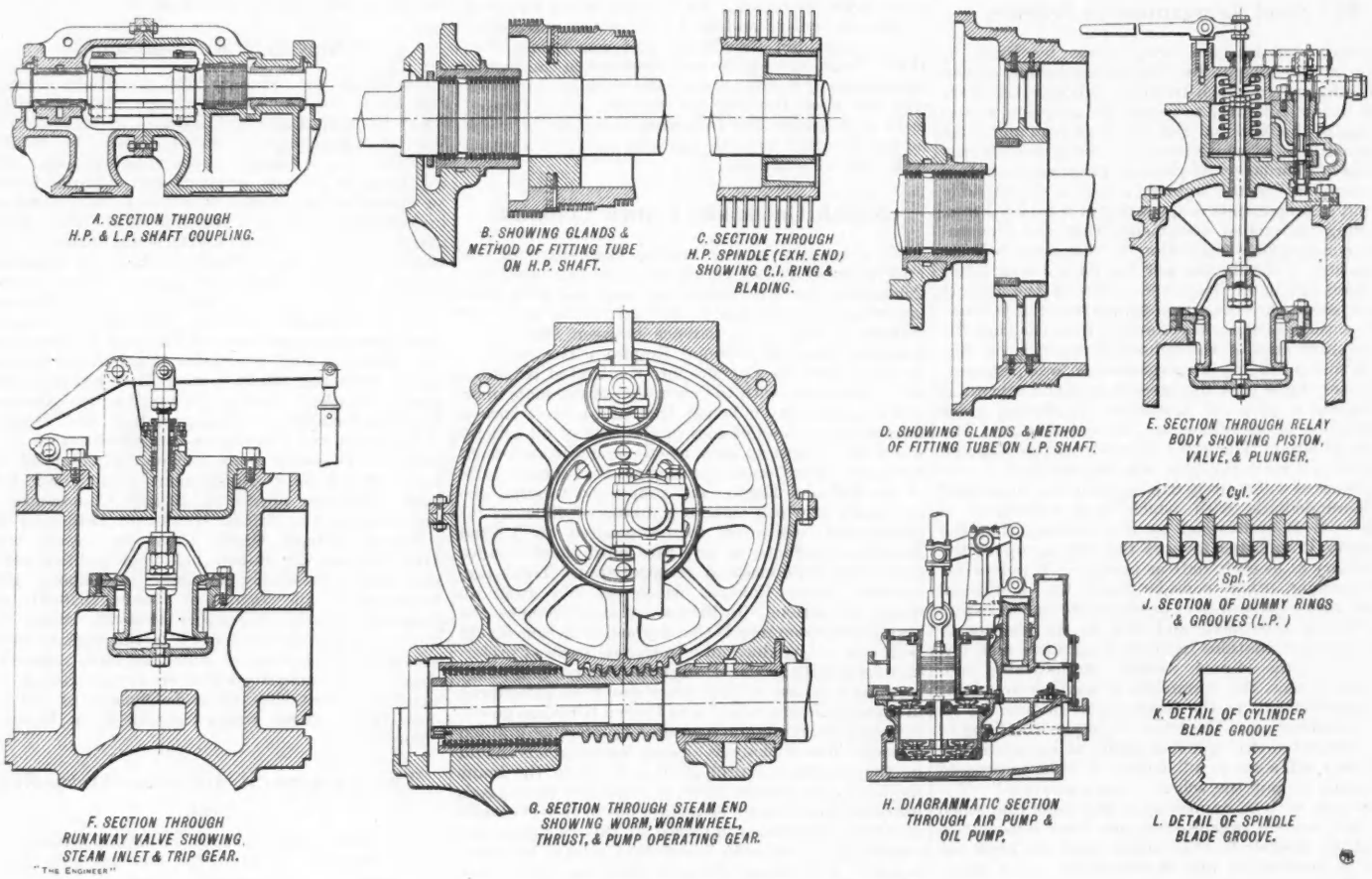

A. SECTION THROUGH H.P. & L.P. SHAFT COUPLING.
B. SHOWING GLANDS & METHOD OF FITTING TUBE ON H.P. SHAFT.
C. SECTION THROUGH H.P. SPINDLE (EXH. END) SHOWING C.I. RING & BLADING.
D. SHOWING GLANDS & METHOD OF FITTING TUBE ON L.P. SHAFT.
E. SECTION THROUGH RELAY BODY SHOWING PISTON, VALVE, & PLUNGER.
F. SECTION THROUGH RUNAWAY VALVE SHOWING STEAM INLET & TRIP GEAR.
"THE ENGINEER"
G. SECTION THROUGH STEAM END SHOWING WORM, WORMWHEEL, THRUST, & PUMP OPERATING GEAR.
H. DIAGRAMMATIC SECTION THROUGH AIR PUMP & OIL PUMP.
Cyl.
Spl.
J. SECTION OF DUMMY RINGS & GROOVES (L.P.)
K. DETAIL OF CYLINDER BLADE GROOVE
L. DETAIL OF SPINDLE BLADE GROOVE.

FIG. 32—VARIOUS DETAILS OF ELBERFELD TURBINE

In addition to driving the air pump, the connecting-rod also gave motion to the reciprocating oil pump which served the forced lubrication system. The oil pump, of the solid plunger type, is shown on the right-hand side of the air pump, its plunger being actuated by the rocking lever above. Reference to Fig. 31 will make clear the thorough system of forced lubrication applied to turbine, alternator, and exciter equally. Oil under pressure from the pump was led separately to every bearing, being first cooled by passing through the oil cooler seen beneath the condenser. The spent oil flowed back through large pipes to the large settling tank situated close to the pump, which provided a head of oil on the pump suction. Except for the fact that mechanically driven reciprocating pumps are no longer used for the purpose, the principle of the lubricating system is thoroughly modern, no material change from the scheme devised so long ago having been found necessary.

The type of labyrinth packing used for the dummy pistons is shown to a large scale in Fig. 32J. The circumference of the dummy piston was turned with a number of grooves, the side of each groove at which steam passing the dummy would enter being provided with three sharp-edged serrations. The edges of these serrations ran practically in contact with brass segmental rings projecting from the interior wall of the casing. The early application of the principle laid down by Parsons, namely, that where there was a risk of contact between metal surfaces running at high relative speeds, safety was only to be found by providing one surface with thin fins which could instantly be worn away, is exemplified in the design.

The grooves for holding the fixed and moving blades, respectively, are illustrated in Figs. 32K and 32L. For the fixed blades a plain, but slightly undercut groove was used, into which the blades were held by brass distance pieces caulked between them. The blading on the rotor, having to withstand centrifugal force, needed to be held more strongly, and to this end the grooves were serrated on each side, as shown in Fig. 32L, to furnish a good hold for the caulking. Caulked blading patented and first used, in 1896, is now no longer used, but the method of attachment it illustrated served all needs for many years, being abandoned only when longer blades and higher blade speeds called for different means. With the introduction of caulked blading, came the employment of blade strip drawn to the familiar streamline section resembling that of an aeroplane wing. It was found by experiment that thickening up the convex sides of blades made them very considerably more efficient, and thenceforth the use of profiled blades was adopted as standard practice. A further change was that the "coefficient of opening" was increased from 0·28 to 0·35 during the development of the new blade form.

Turning to the electrical end of the Elberfeld machine, several novel and interesting details of design are to be noted. The construction of the field system will be understood from Fig. 33. On the left of the illustration is shown an innovation in the method of securing the main magnet poles to the yoke. The pole and bobbin are shown in section alongside. The pole was built up of sheet iron laminations, $\frac{1}{4}$in. thick, which were insulated by asbestos paper 0·022in. thick. The external plates were $\frac{3}{4}$in. thick, and the whole was bolted together and cast in position in the cast steel yoke. The ends of the poles were specially shaped to secure a good hold in the cast steel. To facilitate manufacture the yoke was built up of four pieces, each of which carried one pole. From the sectional drawing of the pole it will be seen that the laminations were built up to a greater width towards the end remote from the yoke. This not only provided a clearance for the bolt heads, but furnished also extra magnetic material towards the pole face.

The construction of the bobbins to hold the field coil is also interesting. They were made by casting longitudinal brass strips into a brass flange at the base, the other ends of the strip being secured by a wooden flange. A side view of the bobbin shows the proportion and the spacing of the strips, and a sectional view in plan of one corner further illustrates the construction.

The armature of one of the Elberfeld alternators is illustrated in section in Fig. 34. The drawing shows the general construction and particularly the special ventilating system. This armature was one of the earliest, and perhaps the first to have radial ventilating ducts and a definite system of ventilation. It was built up of laminations arranged into groups $3\frac{7}{16}$in. long in the axial direction, separated by $\frac{1}{2}$in. ducts. These ducts were maintained by brass spacing pieces, which fitted on the shaft. A portion of one of these spacers is shown separately in the illustration. The laminations of the armature core were punched with holes to form axial ventilating channels. Air drawn in through the caps protecting the end windings entered these axial channels and passed out at the periphery of the armature through the series of radial ducts.

The commutator for the exciter armature also showed an advance over previous practice. As will be seen from Fig. 35, it was of the shrunk ring type, and was a very early, if not the first, example of this type of construction. The commutator segments were mounted on brass cone-shaped rings from which they were insulated by means of asbestos. They were held in place by steel rings shrunk on to the commutator over mica insulation. The rings were also designed to serve as balancing rings, grooves being turned in their faces for the fixing of balance weights.

Re-heating Experiments on the Elberfeld Turbines.

Before leaving the subject of the Elberfeld turbines, reference should be made to experiments made on one of these machines before it left the Heaton Works to determine the effect of re-heating the steam after partial expansion. Re-heating of steam is still regarded as very advanced practice, even in the most modern central stations, so that it is worthy of record that so long ago as August, 1900, re-heating was actually tried by Mr. Parsons. His experiments constitute, so far as is known, the first practical work on re-heating steam ever attempted. The exhaust steam from the high-pressure cylinder of the turbine, instead of being led directly to the low-pressure cylinder, was passed on its way through an old locomotive boiler, in which it was re-heated by a fire in the fire box. The pressure at the stop valve was 134 lb gauge. The steam left the high pressure cylinder at a pressure of 10·4 lb. per square inch absolute, and at a temperature of 198 deg. Fah., being, therefore, in a dry condition. It was re-heated in the boiler to 261 deg. Fah., and entered the low-pressure cylinder at a pressure of 9·5 lb. absolute, exhausting to the condenser under a vacuum of 25·8in. The amount of re-heating was, therefore, very small, the steam temperature being only raised by 63 deg. Fah., and the re-heat temperature of 261 deg. Fah. being far inferior to the temperature of the live steam, which was about 450 deg. Fah.

The result of the tests showed that, under the conditions of the experiment, there was no advantage in re-heating the steam, as the reduction in steam consumption was more than counterbalanced by the heat which was supplied. In view of the serious drop in steam pressure between the high and low-pressure cylinders and the very moderate rise in the steam temperature, little or no benefit was to be expected, though, but for the loss of pressure in the re-heating process, there might have been some small practical gain consistent with calculations. The actual gain at a load of 1037 kW was just over 1 lb. of steam per kWh, the consumption being reduced from 21·65 lb. to 20·60 lb. per kWh. The principle of re-heating was abandoned at the time, but it was taken up again later, notably in connection with a turbine at Carville in 1921.

(To be continued.)

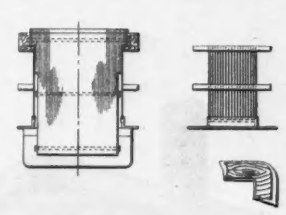


FIG. 33.

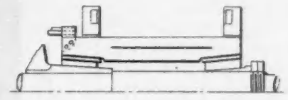
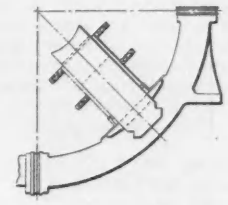


FIG. 35.



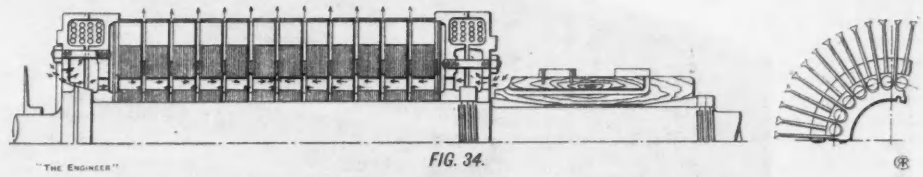


FIG. 34.

FIGS. 33 TO 35—ELECTRICAL DETAILS OF ELBERFELD MACHINE

The New Barking Power Station.

No. I.

WITH the completion of the new section of the County of London Electric Supply Company's Barking power station during 1933, the capacity of the plant was increased from 240,000 to 390,000 kilowatts. While the original "A" station, opened by H.M. The King in 1925, now contains four 40,000 and four 20,000 kW sets, the new section, of which we give a view in Fig. 1, is equipped with two 75,000 kW sets, which are the largest British-made machines at present in service. Although the two power-houses constitute the largest station in this country, and are claimed to form the most extensive station built on a single site in Europe, in due course another section is to be served with coal by the new unloading jetty. The efficiency of the latest plant is expected to show an increase of some 10 per cent. over that of the old, which is among the most efficient running.

In the construction of the new building glass has been used extensively. Above the structure, composed of red brick and white stone, glass occupies three parts of the total height on three sides of the building. The four brick-built chimneys are 250ft. high, and taper from 30ft. at the base to 23ft. at the top. Simplicity has been the keynote of the general design. Unlike the original "A" station, the new B section is devoid of pulverised fuel and steam re-heating equipment. Another difference between the two stations is, of course, that, while the generating units in the old turbine-room are placed crosswise, the much larger machines installed in the new building are arranged longitudinally, as illustrated on page 10 of our issue of January 5th. A site plan is given in Fig. 2, and a plan and elevations of the new station in our Supplement.

Coal-handling Plant.

Extensions to the original coal-handling plant, involving the provision of new jib cranes, travelling bridge, and belt conveyors, were carried out for the most part by Fraser and Chalmers. The plant is now extensive, and we propose to consider it in its entirety. It is designed mainly for handling sea-borne coal, which may be transferred from the colliers either to the overhead bunkers of the boiler-houses, or to the running coal storage ground between the boiler-houses and jetty. Rail-borne coal can also be handled. The ferro-concrete jetty is 1000ft. long, and accommodates colliers up to 5000 tons capacity, the depth of water at ordinary low spring tides being approximately 14ft.

From the drawing, Fig. 3, the general method of operation will be understood. Coal discharged from the holds of the colliers by means of grabbing cranes is transferred to belt conveyors at the south side of the running coal store. These conveyors serve to distribute the coal from any of the cranes on to any of the travelling bridges, which are equipped with belt conveyors arranged so that coal may either be placed in the running store, or be passed forward to the conveyor belts adjacent to the south gable ends of the boiler-houses. The conveyor belts at the south gable ends of the boiler-houses then feed the coal to the underground filler pits of the gravity bucket conveyors, which supply the overhead bunkers in the respective boiler-houses, the belts being arranged so as to distribute the coal from the travelling bridges to the various gravity bucket conveyors.

Jetty Cranes.

On the jetty there are at present six coal-unloading cranes, two supplied by Fraser and Chalmers, two by Stothert and Pitt, and two by Sir William Arrol and Co. The latter are shown in Fig. 4, from which it will be seen that the substructure is designed so that gauge clearance is provided for a single line of railway track beneath the cranes, which run on a 23ft. gauge track. Throughout the complete unloading of a collier the average unloading rate of each of the six cranes is 100 tons per hour, but they are designed so that under the most favourable conditions the rate of handling is 200 tons per hour. On test each of the cranes illustrated handled 250 tons per hour from ship to receiving hopper or gantry.

After coal is grabbed from the hold it is discharged into receiving hoppers fixed to the jib crane structures, and these hoppers feed the coal to cross conveyors

THE NEW BARKING POWER STATION

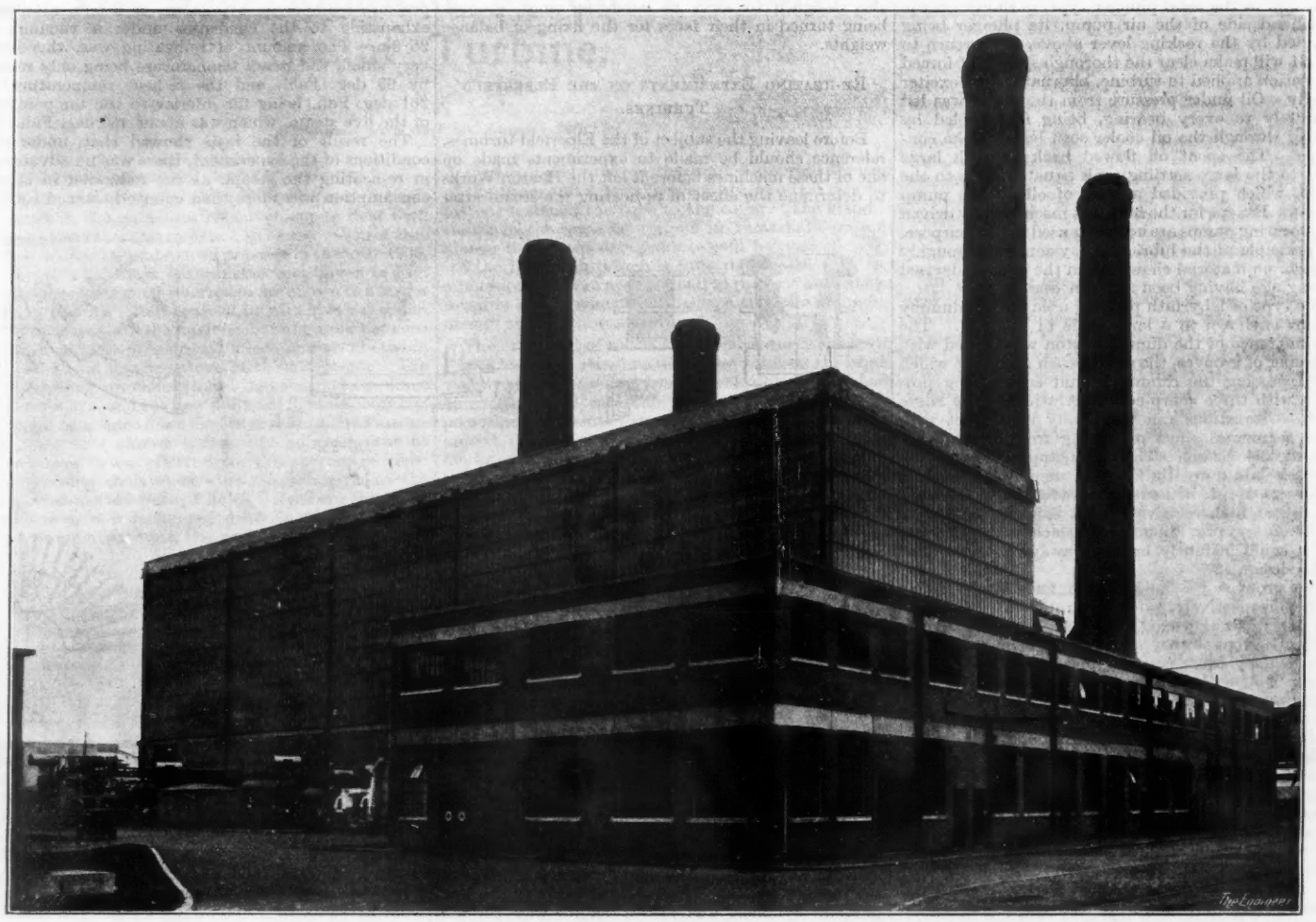


FIG. 1—EXTERIOR VIEW

fixed to and travelling with the crane structures. The axes of these cross conveyors are at right angles to the jetty, and the conveyors extend to the rear of the jetty, where they discharge to the conveying belts at the south of the running coal store. In the event of a breakdown of a cross conveyor, or of Nos. 1 and 2 belt conveyors, coal can be discharged direct from the colliers to the belt conveyors situated on the travelling bridges, which are placed in a position convenient for this operation. The coal is then grabbed from the collier, the crane completely slewed, and the grab is discharged into the emergency hoppers on the bridges. Under these conditions the maximum rate of handling coal is guaranteed not to be less than 170 tons per hour.

The Fraser and Chalmers cranes (Nos. 1 and 2) are of the "Shoosmith" type. To allow the most easterly of these cranes, and both of the new Arrol cranes (Nos. 5 and 6) to pass the junction boxes B, C, L, situated in the middle of the conveyor run at the south side of the coal store, the structure carrying the cross conveyor is hinged at a point close to the crane substructure. The cross conveyors of both the Fraser and Chalmers cranes are arranged to discharge coal only to conveyor No. 1 west, which travels in a direction west to east. Arrangements are provided on these cranes for weighing the coal grabbed from the colliers. At the discharge ends of the cross conveyors of the crank luffing Stothert and Pitt cranes, the chutes are arranged so that the coal can be discharged to No. 1 or No. 2 conveyor.

BELT CONVEYOR SYSTEM.

As the drawing, Fig. 3, shows, conveyor No. 1 west consists of two portions, a long horizontal portion, and a short inclined portion 1 A. Conveyor No. 1 west is designed to receive coal from the jetty cranes. Normally, cranes Nos. 1, 2, 3, and 4 are used on the portion of the jetty immediately in front of this conveyor, but cranes Nos. 5 and 6 can travel on to this portion of this jetty, so as to feed conveyor No. 1 west. The belt runs in a direction from west to east, and the rate at which coal is handled is 400 tons of rough small coal per hour, which is discharged on the short inclined conveyor 1 A, provided to raise the coal to enable it to be discharged on to conveyor No. 1 east, or conveyor No. 2 west, both at the same level as conveyor No. 1 west. The junction house B contains the driving gear for conveyor No. 1 west and the inclined conveyor 1 A. As mentioned above, conveyor No. 1 east can receive coal from conveyor No. 1 A, and it forms a continuation of conveyor No. 1 west on the same centre line and at the same level Conveyor No. 1 east is also designed to receive coal from the cross conveyors of No. 5 and 6 jetty cranes, and, if required, No. 1 crane can be travelled on to the eastern portion of the jetty in front of No. 1 conveyor east, and be used for discharging coal from colliers to this conveyor. The conveyor travels in a direction west to east, and is capable of handling 800 tons per hour of run-of-mine coal. It is also arranged to receive run-of-mine coal from No. 10 conveyor on No. 3 travelling bridge, so that, if required, this coal can be reclaimed from the running coal store and be conveyed to the crushing plant.

Conveyor No. 1 east terminates in an inclined portion indicated in Fig. 3 as "Weighing Conveyor," this inclined portion being necessary to enable the coal to be discharged from conveyor No. 1 east to conveyor No. 2 east, or to crusher conveyor No. 1. Coal is passed from conveyor No. 1 east to crusher conveyor No. 1 through a screen, which will handle run-of-mine coal at the rate of 800 tons per hour. It is contained in junction house N, and all sizes of coal up to those which will pass a 2in. ring pass through the screen, and are delivered to conveyor

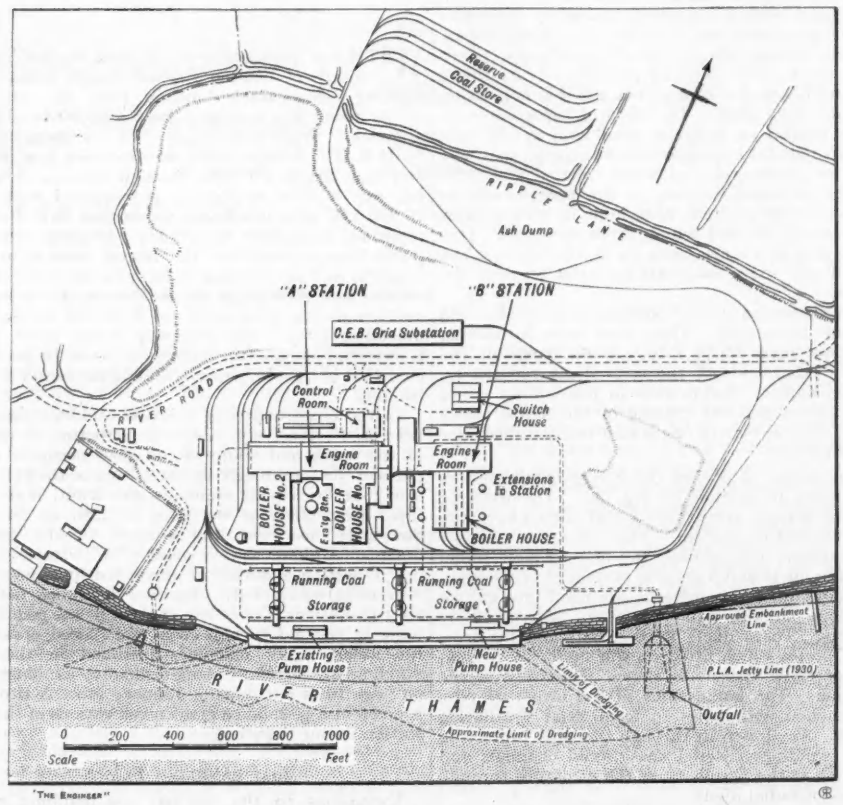


FIG. 2—SITE PLAN OF BARKING POWER STATION

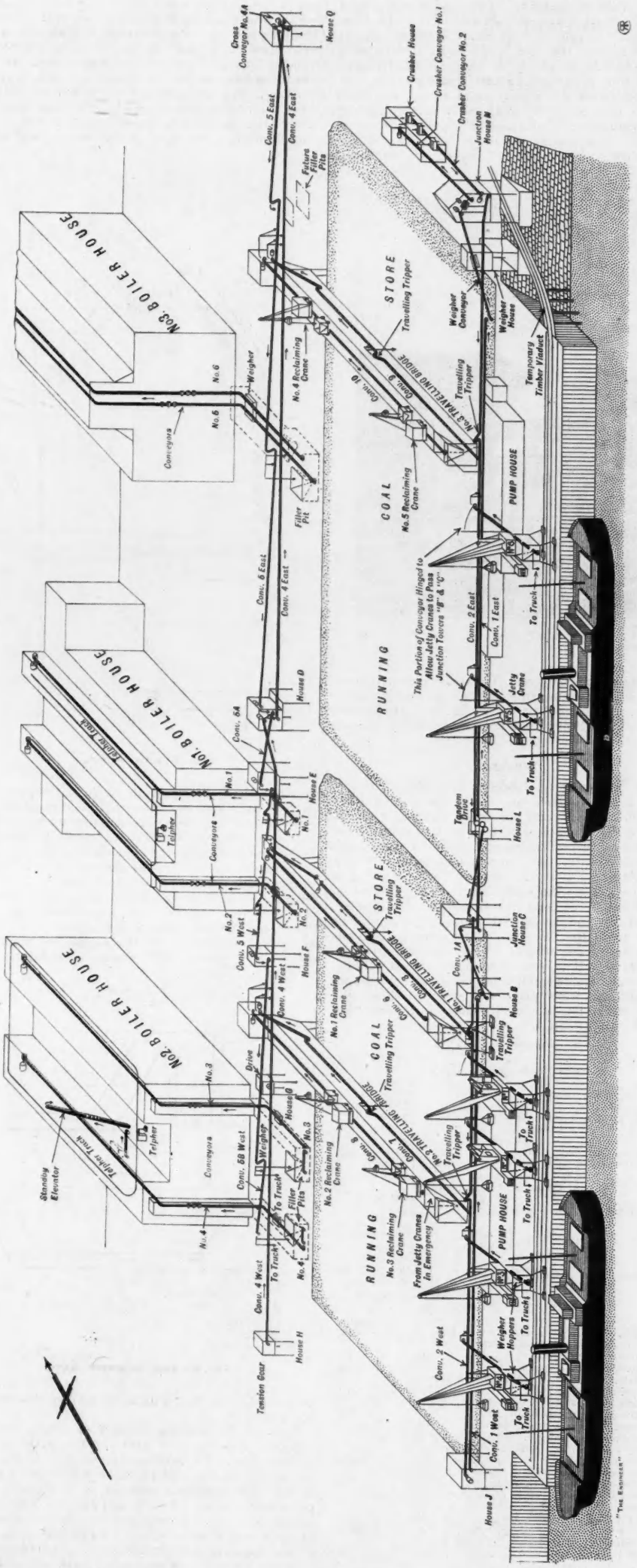


FIG. 3—COAL HANDLING PLANT FOR OLD AND NEW BOILER-HOUSES

No. 2 east. The remainder is retained on the screen, and is fed forward on to the crusher conveyor No. 1, which takes it to the crushers.

Crusher conveyor No. 1 will handle coal of this grading at the rate of 500 tons per hour. Crusher conveyor No. 2 has a similar hourly capacity and receives the crushed coal from the crushers and delivers it to conveyor No. 2 east. This conveyor receives coal either from conveyor No. 1 east, or crusher conveyor No. 2, which runs in a direction east to west, it being capable of handling run-of-mine coal at the rate of 800 tons per hour. In the event of a breakdown in any part of conveyor No. 1, coal can be discharged direct from the cross conveyors on the jetty cranes to conveyor No. 2 east. A travelling hopper is also provided in conjunction with the conveyor, so that the grabs of either of the jetty cranes can discharge direct on to conveyor No. 2 east. A travelling tripper on the conveyor operates in conjunction with the travelling bridge, and is arranged so that coal can be discharged from this conveyor to conveyor No. 9, situated on No. 3 travelling bridge.

At the end of its run conveyor No. 2 east can also discharge on to conveyor No. 2 west and the tripper mentioned enables a portion of the coal being carried to be discharged to conveyor No. 9, while the remainder is returned to the belt for conveying forward and to be discharged on to conveyor No. 2 west, which has a capacity of 400 tons of rough small coal per hour and, as mentioned, receives coal from conveyor No. 2 east. Coal can also be received from conveyor No. 1A or direct from the cross conveyors on the jetty cranes Nos. 3 and 4. A travelling hopper is provided in conjunction with the conveyor, so that the grabs of the jetty cranes can discharge direct on to conveyor No. 2 east. Travelling trippers enable coal to be discharged either on to conveyor No. 3 situated on No. 1 travelling bridge or on to conveyor No. 7 situated on No. 2 travelling bridge.

Travelling Bridges.

At present there are three travelling bridges, but when further extensions are necessary a fourth bridge will be provided. Bridges Nos. 1 and 3 were designed and constructed by Fraser and Chalmers and bridge No. 2 by Babcock and Wilcox. The bridges span the running coal store and the span between the centre of the tracks is 197ft. 6in. The total length of the track is 1100ft. and 62,000 tons of coal can be stored when stocked to a depth of 15ft. above the ground level. Arrangements have been made in the design of the bridges and of the conveyors and junction houses to enable No. 1 bridge to be travelled over the easterly portion of the running coal store and No. 3 bridge over the westerly portion. Power for travelling the bridges and for the supply to the reclaiming cranes situated on the top chords of the bridges is taken from plug pillars by means of flexible trailing cables.

On the No. 1 Fraser and Chalmers bridge, which permits coal to be stored to a depth of 20ft., there is a conveyor designated No. 3, which receives coal from conveyor No. 2 west, the bridge conveyor being capable of handling coal at a maximum rate of 400 tons per hour. A travelling tripper enables the coal to be discharged from this conveyor at any point across the width of the running coal store and the coal may also be passed forward for delivery to the filler pits of the boiler-houses, either direct or by way of the conveyors Nos. 4 and 5. Alternatively, half the coal may be placed in the store and half passed forward for delivery to the boiler-houses. Conveyor No. 3 on the bridge may also receive coal direct from the jetty cranes. For reclaiming the coal from the running store a reclaiming crane No. 1 with a maximum hourly capacity of 75 tons, situated on the top chord of the bridge, is used in conjunction with conveyor No. 6. The coal is grabbed from the store and discharged into a receiving hopper which travels with the crane. The hopper feeds the No. 6 bridge conveyor, which has a capacity of 100 tons per hour.

At the north end of its run the conveyor normally discharges the coal into a hopper over conveyor No. 4 west, but the chutes are designed so that if the bridge happens to be opposite either of the boiler-house filler pits the coal can be discharged direct into the pit. On the No. 2 Babcock bridge the arrangement of No. 7 conveyor is similar to that of No. 3 conveyor on bridge No. 1. There are, however, two reclaiming cranes with an hourly capacity of 100 tons. The coal fed into the hoppers travelling with the cranes is fed on to No. 8 bridge conveyor, which at the north end of the run normally discharges into a hopper over conveyor No. 4 west, but as in the case of No. 1 bridge, if the bridge happens to be opposite either of the boiler-house filler pits the coal can be discharged direct into the pit. The arrangement of conveyor No. 9 on the No. 3 Fraser and Chalmers bridge is practically the same as that of Nos. 3 and 7 conveyors on bridges Nos. 1 and 2. There are two cranes, each with an hourly capacity of 125 tons, and conveyor No. 10 used in conjunction with them has a capacity of 250 tons per hour of rough small coal. The conveyor can be run in a northerly or southerly direction. When running in the direction south to north the conveyor is used for carrying coal reclaimed from the store for feeding the boiler-house filler pits, and when in the reverse direction the conveyor receives run-of-mine coal from either of the Nos. 4 or 5 reclaiming cranes and discharges on to conveyor No. 1 east, in

order that the coal may be crushed. If, owing to the breakdown of conveyor No. 1 east, crusher conveyor No. 1, crushers, crusher conveyor No. 2, or conveyor No. 2 east, it is impossible to deal with run-of-mine coal at the crushing plant immediately upon its arrival, the coal may be temporarily placed in the running coal store and crushed when convenient. It can then be returned to the store or be delivered to the boiler-houses.

Conveyors Nos. 4 west and No. 5 are carried on a common structure erected to the north of the running coal store and adjacent to the boiler-house filling pits. Conveyor No. 4 west runs in a direction west to east and receives coal from the conveyors on Nos. 1 and 2

FIG. 4—JETTY CRANES

travelling bridges. In the case of No. 1 bridge conveyors Nos. 3 and 6 both discharge on to this conveyor, which also receives the coal from conveyors Nos. 7 and 8 on bridge No. 2. Rough small coal can be handled on conveyor No. 4 west at the rate of 400 tons per hour. At the end of its run it terminates in an inclined portion which discharges either to conveyor No. 5A, which serves to distribute coal to gravity bucket conveyors 1, 2, 3, or 4 or to conveyor No. 4 east, carried on a common structure with conveyor No. 5 east and on the same centre lines as conveyors No. 4 west and No. 5 west respectively. The capacity of conveyor No. 4 east is 400 tons per hour of rough small coal. As explained, it receives coal from conveyor No. 4 west and also from conveyors Nos. 9 and 10 on travelling bridge No. 3, and it runs in a direction west to east and terminates in an incline. At the end of its run it discharges "over end" on to a short wide slow-running belt conveyor No. 4A, which is provided for the purpose of transferring coal to conveyor No. 5 east, which runs in a direction east to west and also has a capacity of 400 tons per hour of rough small coal. As stated, coal is received at the east end of this conveyor and can also be received direct from either conveyors Nos. 9 and 10 on travelling bridge No. 3. By means of a fixed tripper coal can be discharged at a suitable point for discharging into the filler pit serving gravity bucket conveyors Nos. 5 and 6. The tripper is designed so that all the coal may be returned to the belt for carrying forward, and the chutes are arranged so that any quantity up to half the quantity being carried by the belt may be delivered to the filler pit, the remainder being returned to the belt for conveyance forward. At the end of its run conveyor No. 5 east discharges on to No. 5A conveyor, another fixed tripper being embodied in conveyor No. 5 east to serve a filler pit in a future boiler-house.

Conveyor No. 5 west consists of three portions, viz., 5A, 5, and 5B. The first-mentioned portion consists of a short length of inclined conveyor, which receives coal from either conveyor No. 5 east or conveyor No. 4 west and discharges to conveyor No. 5, on which there are two fixed trippers, each fitted with coal sampling apparatus and from which points coal can be fed into the filler pits serving gravity bucket conveyors Nos. 1 and 2. The trippers are arranged so that any portion of the coal up to half of the total quantity can be discharged to the filler pits, the remainder being returned to the belt for conveyance forward. Conveyor No. 5 discharges at the end of its run to No. 5 B conveyor, on which there are two fixed trippers with coal sampling apparatus, from which points coal can be fed into filler pits serving gravity bucket conveyors Nos. 3 and 4. All the gravity bucket conveyors were supplied by Robert Dempster and Sons.

COAL WEIGHING EQUIPMENT.

All incoming coal can be weighed. Avery hopper weighing machines are provided on jetty cranes Nos. 3 and 4. From the receiving hopper into which the grab discharges the coal falls into the automatic recording hopper weigher, from which it is discharged on to the cross transfer belt conveyor and is conveyed forward in the normal way. The jetty cranes Nos. 5 and 6 are devoid of weighing apparatus, but a Denison belt weigher is provided on No. 1 belt east and is arranged so that the tare of the empty belt is subtracted from the weight of the loaded belt. In addition to this apparatus, which measures the seaborne coal received, Denison weighers and recorders are used in conjunction with each of the gravity bucket conveyors. These machines weigh sections of the loaded and empty strands of the conveyor and automatically record the total quantity of coal being handled by each conveyor. The total quantity of coal placed in the running store can be obtained from the difference between the total weight of coal recorded by the belt weigher and that recorded by the six gravity bucket conveyor weighers.

BOILERS.

Eight stoker-fired Babcock and Wilcox boilers installed in two lines, as shown in the sectional elevation on page 120, constitute the boiler equipment of the new station. On the west side of the boiler-house the steam raising units have Babcock furnaces, stokers, and plate air-heaters, Foster economisers, Davidson Sirocco fans, and dust collectors. With the exception that the boilers on the east side have Usco stokers and plate air-heaters, supplied by the Underfeed Stoker Company, the equipment of the two lines is the same. From the illustration of one side of the boiler-house given on page 124 it will be seen that there are no galleries on the boiler fronts. When inspection and repairs are necessary the front plates are dropped down and tubular scaffolding is erected. The leading particulars of the boilers are given in the tables below.

Heating Surfaces.

Boiler	21,700 sq. ft.
Furnace (effective superficial wall area, excluding any boiler tubes)	1776 sq. ft.
Superheater (fully tubed)	8030 sq. ft.
Economiser	22,176 sq. ft.
B. and W. air-heater (four units)	16,650 sq. ft.
Usco air heater (four units)	17,595 sq. ft.
Combustion chamber volume	13,400 cu. ft.
Weight of water in boiler (hot)	101,000 lb.
Weight of water in Bailey walls (hot)	15,819 lb.
Weight of water in Bailey wall connections (hot)	4409 lb.
Weight of water in economiser (hot)	6450 lb.
B. and W. stoker (four units) Size	One Twin 30ft. × 22ft.
B. and W. stoker (four units) Grate area	600 sq. ft.
Usco stoker (four units) Size	One Twin 30ft. × 22ft. 6in.
Usco stoker (four units) Grate area	675 sq. ft.

	Economical output.	Maximum continuous output.
Output, lb. of steam per hour	205,000	256,000
Steam pressure at superheater outlet, lb. per square inch gauge	625	625
Steam temperature, degees Fah.	825	840
Feed water temperature at inlet to economiser, degrees Fah.	340	340
Estimated temperature of water leaving economiser, degrees Fah.	418	435
Guaranteed efficiency (net calorific value of coal, per cent.)	90	—
Working pressure in drum, lb. per square inch (gauge)	646	657½
Working pressure at inlet to economiser, lb. per square inch (gauge)	658½	677
Estimated temperature of air leaving air heater, degrees Fah.:		
B. and W. air heater	242	248
Usco air heater	245	250
Air pressure under stokers:		
B. and W. stokers, inches W.G.	2	2
Usco stokers, inches W.G.	2½	2½

The boilers are three-pass vertical header units with the solid forged mild steel drum at the rear. Each unit is fifty-six headers wide, made up of a lower and upper bank, the lower bank forming a nest of tubes with alternate rows four and five high, the first alternate rows of one and two tubes high being widely pitched both vertically and horizontally to form a slag screen. The upper nest of tubes is sixteen high and there are three rows of return tubes. The superheater is arranged between the upper and lower nests. All the main tubes have an outside diameter of 3½in. and are 20ft. long. The drum has an inside diameter of 4ft. and is 2½in. thick, the overall length being approximately 41ft. Small hoppers receive the dust from the hopper-shaped space between the second and third

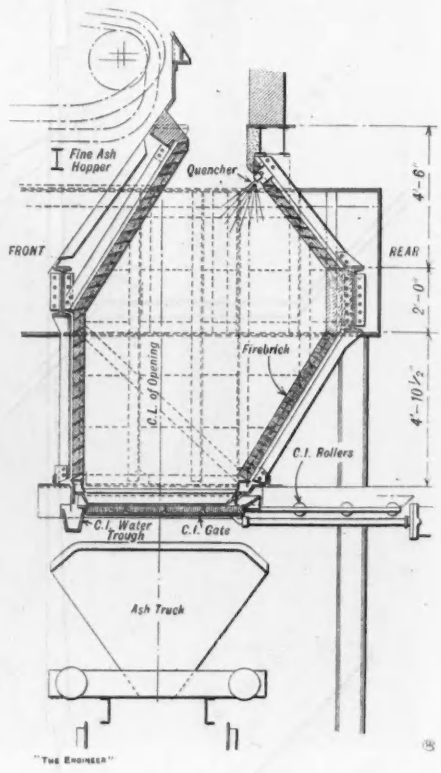


FIG. 5—ASH HOPPER

passes of the boilers and discharge it through pipes and valves to hoppers between the economisers and heaters, the valves being arranged for operation from the rear of the stoker and firing level. Between the top of the grate and the underside of the first row of boiler tubes the mean height of the Bailey furnace with water-cooled walls on all sides is 23ft. At the bottom of the front wall there is a short arch of the flat suspension type, 3ft. 10in. long and 12in. high, and above it there are two rows of nozzles for the supply of secondary air. Each water wall forms a separate unit

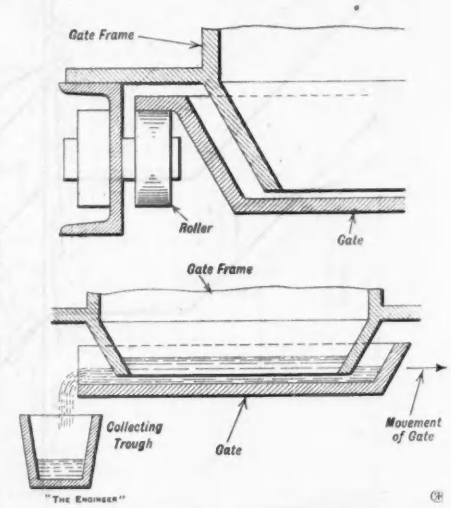


FIG. 6—ASH HOPPER GATE

connected to the boiler drum by its own downcomers and risers.

Both the Babcock and Underfeed stokers have two separate self-contained grates, each with its own driving gear. To facilitate the control of the fires, an independent air supply has been provided for each grate. The travelling grates of the Underfeed Company's stokers are 30ft. wide and 22ft. 6in. long, giving an effective area of 675 square feet. As the stokers are of the closed front type, air is admitted through the return chain without risk of leakage. Each twin stoker is driven by means of two eight-speed, self-contained gears, one on each side of the stoker. The setting has no radiation arch, as is necessary in the smaller com-

bustion chambers. A small ignition arch is provided to ignite the green coal as it is fed on to the grate, while a cooling arch at the rear of the stoker serves to cool the ash and clinker. Secondary air is admitted fairly high in the combustion chamber, so that it intermingles with the gases in the hot combustion zone and creates complete combustion. The division between the centre of the stokers to separate the two grates is provided in the case of the Babcock stokers by filling in the centre frame of the stoker with brickwork, while in the case of the Underfeed stokers a mild steel division plate is fitted.

Ash-handling Plant.

Two ash hoppers are provided for each boiler below the rear end of each grate. They were installed by the Ash Company (London), Ltd., which was responsible for the ash and dust-handling equipment. The cast iron hoppers, shown in Fig. 5, are lined with a special refractory, and the hopper gates are of the company's patented water-collecting type, operated by pistons controlled by oil at a pressure of 180 lb. per square inch, each row of boilers having two

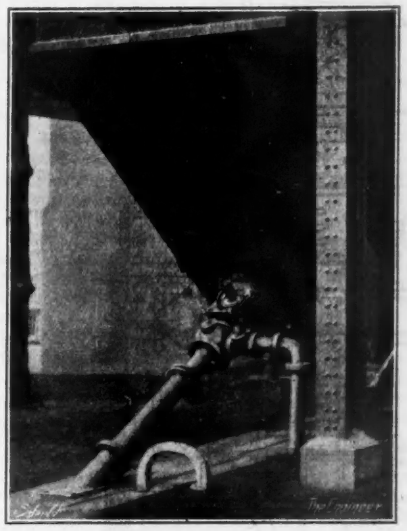


FIG. 7—DUST COLLECTING HOPPER

high-pressure oil-pumping units. The gate frame dips down into the gate itself, which is in the form of a three-sided tray, as shown in Fig. 6. The quenching water underflows the baffle formed by the gate frame, passes down the sides of the gate, and is collected, as shown, in a trough, and is piped away to waste. Despite the fact that a considerable amount of quenching water is continually entering the hoppers, the water collection of these gates ensures a perfectly dry ash basement, and as the gates are suspended by an inverted track passing over the gate frame rollers, dust cannot accumulate on the track, and fine clearances between the frame or gate can be provided without risk of jamming. Needless to say, the quenching process results in a minimum amount of dust. The water supply for the quenchers is taken from a water main running the whole length of the boiler-house, and an isolating valve is provided on the connection to each unit. Each quencher has a shut-off cock, so that in the event of a jet becoming choked, the water supply can be cut off and the jet cleaned out. The ashes are discharged from the hoppers into trucks which convey them to a dump. Below each grate there is a separate riddling hopper which serves as an air receiver for the forced draught air supply, which is delivered to the hopper through openings in the front plating.

The dust from the multiple cyclone grit arresters is discharged continuously into storage hoppers, Fig. 7, outside the building, and when full, the hoppers are discharged by means of "Hydrovac"

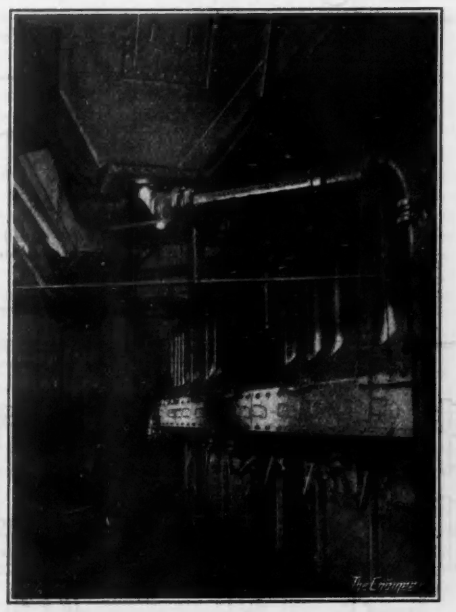


FIG. 8—DUST HOPPER

ejectors into 18in. "Hydrojet" sluiceways provided on each side of the boiler-house. The ejectors have a very positive suction action, and pull the dust out of the storage hoppers at the rate of from 60 to 80 tons per hour, and discharge it into the sluiceway in the form of a completely wetted-down slurry. The ejectors use the same water at 100 lb. pressure as is used in the sluiceways. The sluice discharges into a sump in which there are two "Hydroseal" pumps, which discharge the slurry through a pipe line 1400ft. long.

For dealing with the dust which collects below the economisers and air heaters of the boilers at the firing floor level the Ash Company's "Hydrovac" air suction system is employed. The suction is provided by the same type of ejector which discharges into the sluiceways, and the dust is fed into the suction lines by means of windswept dust valves. Immediately above the sluiceway there are twin ejectors working in parallel which create a powerful suction, whilst immediately below each hopper outlet there is a "windswept dust valve," to be seen in Fig. 8. These valves are operated simultaneously by the movement of an arm through 90 deg., resulting in the admission of air and the opening of the valves to the suction line. The object of these valves is to ensure that no more dust will be sucked out than can be carried by the pipe line. Air is drawn into the valves by the suction created by the ejectors, and it picks up the dust from the valve and conveys it to the ejectors through a 4in. pipe line, all bends, laterals, &c., in this pipe line subject to abrasion being of special wear-resisting "Asheolite" material. At the end of each sluiceway is a sump and pump-house. Each pump-house contains one horizontal pump for supplying the high-pressure sluiceway and ejector water, and two vertical-spindle ash pumps, Fig. 9, for discharging the slurry through the pipe line, which passes down the east side of the boiler-house through the turbine-room basement past the main switch-house under the road, finally to a point some 300ft. to 400ft. beyond the C.E.B. outdoor sub-station. The pumps are also used for discharging the effluent from the water-softening plant, and any other station refuse that has to be disposed of along the same pipe line.

Forced and Induced Draught Fans.

Each boiler has two forced and two induced draught Davidson Sirroco fans at the firing floor level. The forced draught fans draw the air through the air heater and discharge into the riddlings hoppers below the

FIG. 9—SLURRY PUMP MOTORS

stokers, while the induced draught fans which are arranged in the flues leaving the dust collectors discharge into the flues leading to the chimneys. On two of the boilers the double inlet forced and induced draught fans are coupled to their motors through Vulcan Sinclair hydraulic couplings, while those on the remaining six units are directly coupled to their motors by Wellman Bibby flexible couplings. The 45in. forced draught fans are driven by a 125 B.H.P. two-speed motor, while the 63in. induced draught fans are driven by a 280 B.H.P. two-speed motor. In each case the two motor speeds are 575 and 725 r.p.m., but the maximum speed of the fans with variable speed hydraulic couplings is 3 per cent. less, owing to the coupling slip. All the motors are closed air circuit, totally enclosed, three-phase, 50-cycle, squirrel-cage machines, wound for 400 volts. The maximum duty of the induced draught fans is 67,000 cubic feet of gases per minute at 298 deg. Fah.,

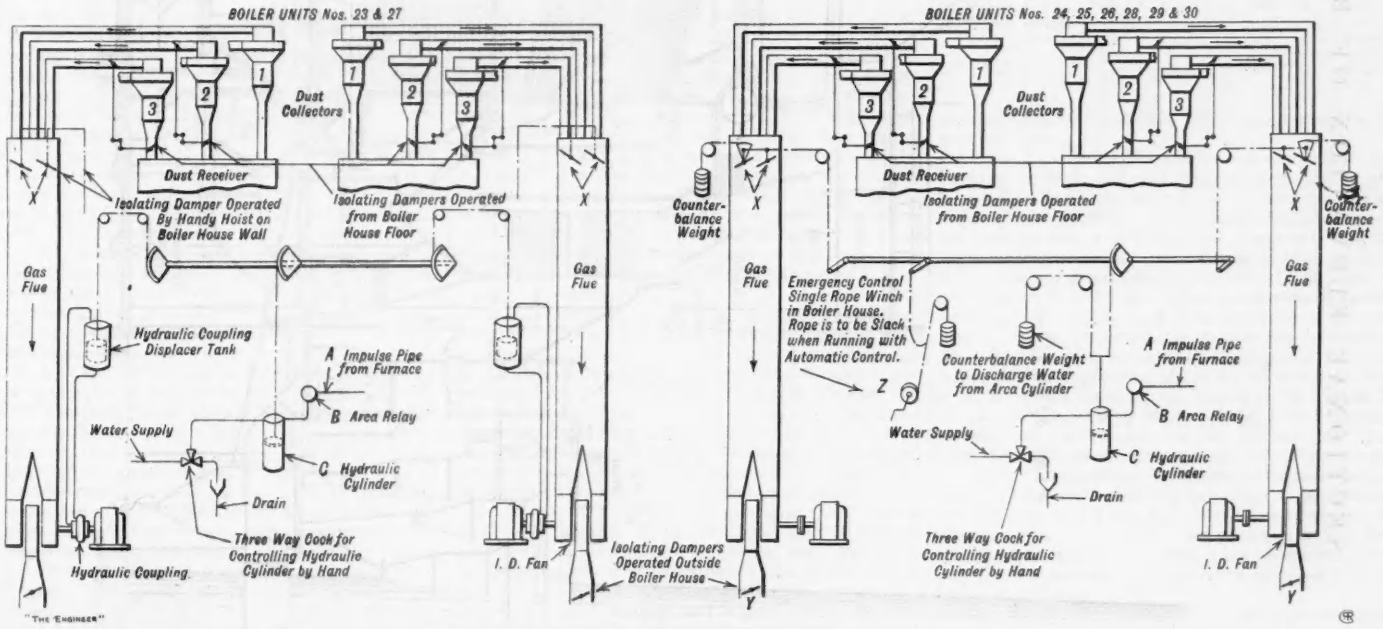
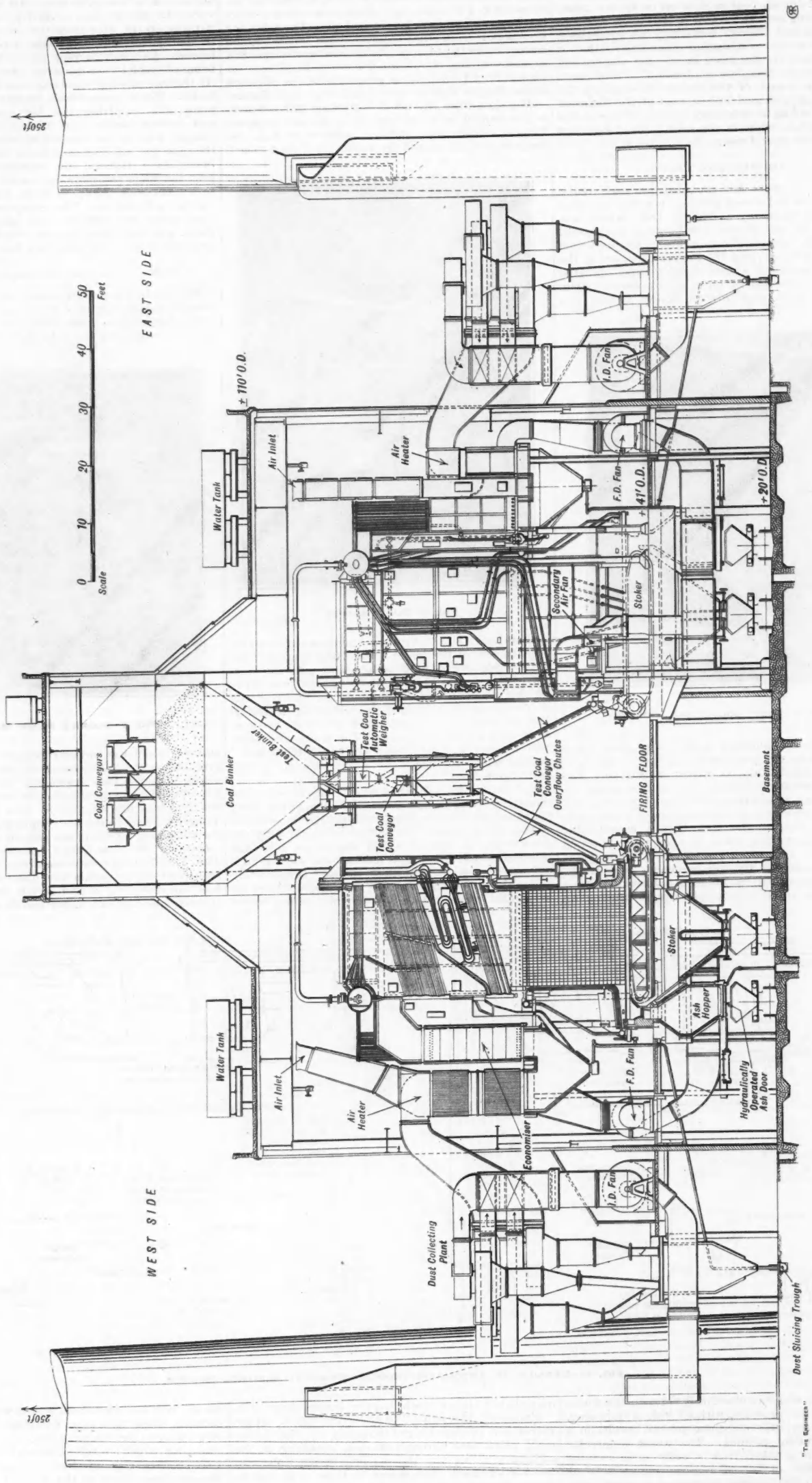

BOILER UNITS Nos. 23 & 27
Dust Collectors
Dust Receiver
Isolating Damper Operated By Handy Hoist on Boiler House Wall
Isolating Dampers Operated from Boiler House Floor
Gas Flue
Hydraulic Coupling Displacer Tank
A Impulse Pipe from Furnace
B Area Relay
Water Supply
C Hydraulic Cylinder
Drain
Three Way Cock for Controlling Hydraulic Cylinder by Hand
Hydraulic Coupling
I. D. Fan
Isolating Dampers Operated Outside Boiler House
"THE ENGINEER"
BOILER UNITS Nos. 24, 25, 26, 28, 29 & 30
Dust Collectors
Dust Receiver
Isolating Dampers Operated from Boiler House Floor
Counter-balance Weight
Gas Flue
Emergency Control Single Rope Winch in Boiler House. Rope is to be Slack when Running with Automatic Control.
Counterbalance Weight to Discharge Water from Arca Cylinder
A Impulse Pipe from Furnace
B Area Relay
Water Supply
C Hydraulic Cylinder
Drain
Three Way Cock for Controlling Hydraulic Cylinder by Hand
I. D. Fan

FIG. 10—DETAILS OF AUTOMATIC INDUCED DRAUGHT CONTROL SYSTEM

SECTIONAL ELEVATION OF BOILER-HOUSE AT THE NEW BARKING POWER STATION



against 11·8in. static W.G., when the speed is 725 r.p.m., and the minimum duty 32,700 per minute at 2·82in. static W.G., and 298 deg. Fah., with a speed of 354 r.p.m. The corresponding figures for the forced draught fans are :—Maximum, 56,000 cubic feet per minute at 248 deg. Fah., 6·5in. static W.G., and 725 r.p.m.; and minimum, 31,100 cubic feet at 248 deg. Fah., 2in. static W.G., and 402 r.p.m. Half of the forced and induced draught fans are right-handed fans, and the other half left-handed. On the suction side of each forced draught fan there is a triple swing damper, and a twin swivel damper on the discharge side.

Two 25in. "Sirocco" single-inlet, secondary air fans are provided for each steam-raising unit on each side of the boiler-house. Each fan draws its air from the forced draught discharge duct on its own side and discharges into the secondary air duct across the front of the furnace. Each of these fans is coupled to a 13½ B.H.P., totally enclosed, frame-cooled, squirrel-cage, single-speed, 50-cycle, 400-volt motor, running at 940 r.p.m. Each fan is capable of giving a boost pressure of 2½in. W.G. above that of the air in the main duct, and as the fan may have to be operated with cold air when the air heater is by-passed the motor is designed to give sufficient power when delivering air at 80 deg. Fah. The duty of each of these secondary air fans is 11,200 cubic feet of air per minute at 2·5in. W.G., at a temperature of 249 deg. Fah., when running at the speed mentioned. As on the suction side of each fan there is a pressure of 2in. W.G., the maximum pressure on the discharge side is approximately 4·5in. W.G.

In the forced draught system the fans draw their air through the air heaters from the top of the boiler house, and deliver it to the stokers, the inlet duct to the air heater being extended to within a few feet of the boiler house roof Each fan discharges its air through a separate duct connected to the front of the riddling hopper, and a damper is provided in each duct.

Automatic Induced Draught Control.

The arrangement of two of the steam-raising units, viz., Nos. 23 and 27, differs, as already mentioned, from that of the other six units in that in the former case hydraulic couplings are used to vary the speed of the induced draught fans, as indicated on the left of Fig. 10, while in the latter case regulation is done by dampers. Automatic control has been adopted in both cases, and the control gear is identical. It consists of an "Arca" pressure relay B and hydraulic cylinder C, the relay being connected to the north side of the furnace by an impulse pipe A. The relay and hydraulic cylinders are supplied with water from town water tanks, associated with the calorifier system, and the discharge is led to a tank in the basement from which it is pumped back to the overhead tanks The furnace pressure controls the operation of the relay, which, in turn, controls the supply of water to and from the hydraulic cylinder, the power stroke of which is downwards. Balance weights, which take the form of hydraulic coupling displacers in the case of units Nos. 23 and 27, and separate weights in the case of the remaining six units, serve to raise the piston, which is connected to a countershaft connected, in turn, to the hydraulic coupling displacers in the case of units 23 and 27 and to the two control dampers X in the case of the remaining six units.

The object of the control gear is automatically to maintain a constant suction pressure of about −0·1in. or −0·2in. W.G. in the furnace when the units are steaming under forced draught conditions. Thus the draught control, when the automatic gear is in operation, only involves the alteration of the forced draught by the operator. On the "Arca" impulse pipe diaphragm adjustment is provided for varying the pressure in the furnace from any value between 0 and −0·5 W.G. The piston valve of the "Arca" relay is fitted with means for adjusting the speed of response of the hydraulic cylinder to variations in the furnace pressure. When owing to a decrease in the forced draught the suction pressure in the furnace increases water is admitted to the cylinder and the piston falls, thus reducing the speed of the hydraulic couplings for units Nos. 23 and 27, and closing the regulating dampers on the other six units. When the suction pressure in the furnace decreases the reverse operation takes place. When under banked conditions or when steaming with induced draught only, or if for any reason the pressure relay is out of service, the water supply to and from the hydraulic cylinder can be hand-controlled by a three-way cock and the cylinder isolated from the relay by means of a valve. If the water supply fails for units Nos. 23 and 27, the isolating dampers marked X on the left of Fig. 10 can be hand-operated by handy hoists at the rear of the units. The fans are then set to run at maximum speed by allowing the water to drain out of the hydraulic cylinder through the hand-controlled cock when the induced draught damper is suitably controlled. In the case of the other six units, after the cylinder has been emptied in the manner described, the dampers would be controlled by the small winch Z. Stops at the top and bottom of the hydraulic cylinders limit the movement of the displacers in the oil tanks and the movement of the dampers, while adjusting screws in certain of the connections enable the relative position of the hydraulic piston and the dampers and displacers to be set. The "Arca" regulator apparatus was supplied by the British Arca Regulator Company, and the Vulcan Sinclair couplings by the Hydraulic Coupling and Engineering Company, of Isleworth. The hydraulic variable-speed couplings* are now well known, and scarcely call for description.

(To be continued.)

Air Pollution in 1932—33.

By JOHN B. C. KERSHAW.

THE Annual Report of the Fernley Observatory in Southport for the year 1932–33 contains the customary summary of the leading results of the air pollution observations for that year in the larger number of towns and cities where these observations are still being made. The writer's thanks are due to the Southport meteorologist, Mr. Joseph Baxendell, for an advance copy of this report. The figures given in this article have been calculated from those contained in it, for the official report of the Air Pollution Board is unlikely to be published for another month or two. The observations for the year ending March 31st, 1933, were carried out by thirty-eight public authorities and by six other authorities at forty-four centres in the United Kingdom, and no fewer than ninety-one deposit gauges, thirteen automatic filters and eleven installations for the estimation of sulphur by the volumetric method were in use.

In view of the completion of the schemes of electric power development and transmission planned by the Central Electricity Board, the writer has devoted special attention this year to the figures for the amount of air pollution by sulphur impurities. The closing down of many of the smaller generating stations and of numberless private power plants, and the resulting concentration of power generation in a small number of highly efficient stations has been accompanied by one disadvantage which is not yet generally recognised. These huge modern stations are equipped in some cases with plant for firing the boilers with pulverised fuel, but only in very few cases are they provided with adequate cleaning and washing plant for the treatment of their exit gases. The Battersea Park power station, which burns solid fuel, is almost alone in making a serious attempt to remove the whole of the solid and gaseous impurities from the waste gases, and in the majority of instances only dry methods of treatment are employed. The increase in the number of these stations and in the amount of fuel they consume annually in pulverised form is bound to be accompanied therefore by some increase in the amount of solid and gaseous impurity in the atmosphere of the locality where they are erected until adequate gas-cleaning and washing plant has been installed at every station. The figures for the Ashington (Northumberland) gauge prove how serious this source of air pollution can be when inadequate gas-cleaning plant is provided. In the writer's opinion, the increase of solid and gaseous impurity in certain districts of London, and in some other towns and cities during the last year or two, is one of the unexpected results of this concentration of electricity supply, and is not due altogether, as some authorities assert, to the increase of population and to the progress of the municipal and private re-housing schemes.

In the following article the figures for the year 1932–33 for total solid impurity and for sulphur acids in the thirty-one towns and cities for which the figures are contained in the Southport report, are presented in Table I., while in Tables II. and III. the detailed figures from the thirteen separate observation stations in the London area for the past three years are given, all the results being calculated as tons per square mile per annum to facilitate comparison with the figures contained in earlier articles.

Group 1 in Table I. contains the towns with total deposits under 200 tons, and it will be observed that Rothamsted, Marple, and Southport again occupy the first three places in the table, as in the previous year, followed by Cardiff, Bournville, and Gloucester. Halifax and Wakefield also occupy quite a good position in this group with total deposits of only 171 tons, and this low total indicates what can be achieved by manufacturing towns when the health authorities are alive to the importance of a clean atmosphere. Birmingham is included in this Group for the first time, because only one return, namely, that from the gauge at West Heath, is available for the comparison, and had the deposit from the gauge in Central Birmingham been included for calculation of the average, this city would no doubt have been in its customary place, in the centre of Group 2. This illustrates the importance when comparing the air pollution results, of taking into consideration the number of observation gauges employed. If only one is installed, and this is placed on the west or south-west side of the town, the results are certainly misleading, and are not comparable with towns where two or more gauges are installed on the less favourable side as regards the prevailing wind. In order to obtain any fair average figures of air pollution therefore for English towns or cities, there ought to be at least two gauges in use, located on opposite sides of the central area, and the average or mean of the results should be employed for making comparisons. It will be noted from Table I. that London, Glasgow, Edinburgh, Halifax, Leeds, Dewsbury, Leicester, Newcastle-on-Tyne, Salford, and Sheffield have all more than two gauges in use, and that the number of towns with only one gauge is being gradually reduced.

The average deposit for the twelve towns which are now included in Group 1 was in 1932–33 159 tons,

TABLE I.—*Comparative Figures for the Total Collection of Solid Matters and of Sulphur Acids in Thirty-one Towns and Cities of the United Kingdom During the Twelve Months Ending March 31st, 1933.*

Group 1.—Under 200 Tons.

	No. of gauges in use.	Tons per square mile per annum.	
		Solids.	Sulphur as SO_3.
Rothamsted	1	90	—
Marple	1	107	—
Southport	2	117	14·2
Cardiff	1	132	15·2
Bournville	2	138	16·6
Gloucester	1	142	—
Halifax	5	171	21·9
Wakefield	2	171	24·9
Cheltenham	1	174	—
Dewsbury	3	178	16·8
Rochdale	1	195	19·5
Birmingham (West Heath)	1	192	44·6
Average..	159	21·7	

Group 2.—200 to 300 Tons.

Leeds	5	214	20·9
Salford	3	226	35·0
Edinburgh	3	223	18·1
Newcastle-on-Tyne	3	232	28·8
Glasgow	9	232	32·5
Hull	2	253	38·4
London	13	256	34·2
Leicester	3	253	29·7
Bradford	2	257	26·7
Walsall	1	257	29·2
Rotherham	2	260	24·0
Sheffield	3	265	25·5
Stoke-on-Trent	2	268	25·0
Average..	246	28·3	

Group 3.—300 Tons and Over.

Loughborough	1	300	—
Castleford	1	307	19·3
St. Helens	1	387	38·9
Burnley	2	358	24·6
Liverpool	2	452	45·7
Ashington (High Market)	1	474	38·9
Average..	379	33·5	

as compared with 146 tons for the same group in the previous year.

Group 2 contains thirteen towns and cities, with deposits between 200 and 300 tons per annum, and, as usual, includes the majority of the larger towns and cities of the country. The London average for its thirteen gauges is 256 tons, as compared with 266 tons in the previous year. Glasgow can show an even greater improvement, namely, 232 tons, as compared with 252 tons ; while Leeds records another striking reduction from 231 to 214 tons in the year under review. How much of this improvement is due to real progress in smoke abatement and how much is due to the depression of trade and manufacturing industry which reached its lowest point during the twelve months ending March, 1933, it is impossible to say, but the returns for the current year when published will no doubt provide the answer to this question. The average deposit for the whole thirteen towns and cities contained in Group 2, however, is 246 tons, or only 1 ton less than the average for the previous year, and the reduced pollution in the three cities named above was very nearly balanced therefore by the increase of impurities in several of the others in the same group.

Group 3 contains the towns with deposits of 300 tons and over, and Loughborough, which was formerly in Group 2, now finds itself relegated to Group 3, with a total deposit of 300 tons, as compared with 263 tons in the previous year. The average deposit of this group is now 379 tons, as compared with 438 tons for the year 1931–32. This improvement of close on 60 tons in the average for the Group is due almost entirely to the reduction of the abnormally high solid deposit at Ashington, from 739 tons in the year 1931–32 to 474 tons in the year 1932–33, as a

* See THE ENGINEER, August 26th, 1932.

result of the introduction of a dry cleaning plant at the colliery power station, which is the chief source of the high returns from this gauge. As regards the sulphur impurities, the averages of the three Groups are 21·7, 28·3, and 33·5 tons respectively, and it is noteworthy that the Birmingham, West Heath Station shows the extremely high figure of 44·6 tons, and is only exceeded by that at one other station, namely, that at Ashington (High Market), in Northumberland.

The London Results.

Tables II. and III. contain the detailed figures of the London observations for total solids and for sulphur impurities for the three years 1930–31, 1931–32, and 1932–33, arranged in two groups according to the location of the gauges, east or west of a line running through Central London. As regards solid impurity, the average deposits for the east side group of observation stations were 289 tons, 291 tons, and 279 tons, while the averages for the west side groups were 243 tons, 244 tons, and 235 tons respectively, and the slight changes noticeable are in the same direction in both groups of stations. The difference in the average amount of impurity collected on the east and west sides of the central line is therefore 45 tons per annum, and this difference would have been considerably greater if the Ravenscourt Park figures for total solids did not spoil the average of the west side group. The following four stations show increases in 1932–33 as compared with the preceding year :—Golden-lane, Victoria Park, Westminster, and Kew Observatory (S), but these increases are more than balanced by the reduction at the other nine stations, and the general average of all the London stations is 256 tons, as compared with 265 tons in 1931–32 and 264 tons in 1930–31. The Ravenscourt Park station, as usual, records the highest deposit of solid matter in the gauge, namely, 472 tons, which is the same as in the previous year ; while the gauge at Kew Observatory (N) collected the smallest deposit, namely, 115 tons. This last-named total gives some indication of what the amount of solid impurity in London's atmosphere may be reduced to, when legislation has been introduced to make compulsory the use of smokeless fuel within the Greater London area, and when every large power or heating plant using pulverised or dust fuel is not allowed to operate until adequate gas cleaning and washing plant is provided for treatment of the waste gases.

Table II.—*The Total Deposit of Solid Matter Collected in the London Gauges during the Three Separate Years, ending March 31st,* 1933.

Locality of gauge.	Tons of deposit per square mile per annum. 1930–31.	1931–32.	1932–33.
East and Central Districts—			
Golden-lane	408	303	344
Archbishop's Park	310	373	331
Horseferry-road	—	379	327
Southwark Park	256	254	234
Finsbury Park	236	240	233
Victoria Park	234	195	208
Average	289	291	279
West and S.W. Districts—			
Ravenscourt Park	461	472	472
Mount-street	—	329	291
Westminster	288	252	283
South Kensington	229	229	192
Wandsworth Common	178	182	163
Kew Observatory (S)	158	129	134
Kew Observatory (N)	147	116	115
Average	243	244	235
Average of all thirteen stations	264	265	256

Table III.—*The Total Amount of Sulphur Collected by the London Gauges during the Three Separate Years ending March 31st,* 1933.

Locality of gauge.	Tons of sulphur as SO_3 per square mile per annum. 1930–31.	1931–32.	1932–33.
East and Central Districts—			
Golden-lane	47	45	46
Archbishop's Park	42	46	43
Horseferry-road	—	40	29
Southwark Park	31	30	28
Finsbury Park	27	26	28
Victoria Park	26	22	28
Average	34·6	35·0	33·6
West and S.W. Districts—			
Ravenscourt Park	106	105	107
Mount-street	—	35	29
Wandsworth Common	22	24	26
Westminster	24	23	23
South Kensington	27	27	23
Kew Observatory (S)	21	19	18
Kew Observatory (N)	19	17	16
Average	36·5	35·7	34·5
Averages of all thirteen stations	35·6	35·3	34·2

Turning now to the figures contained in Table III., showing the sulphur impurities collected by the gauges at the thirteen London observation stations, we see that there is very little difference between the average amount of sulphur impurity collected by the two groups, and for the year under review the totals was 33·6 tons and 34·5 tons respectively. Once again, the Ravenscourt Park total of 107 tons spoils the average for the west side group, for it is more than double that of the sulphur impurity collected by the Golden-lane gauge and is some six times that of the gauges at Kew Observatory. It is certainly time that the local health authorities of Fulham and Acton made some serious attempt to trace the cause of the excessive air pollution of the Ravenscourt Park district of West London, and took the necessary steps to check it, for it has been in evidence now for over three years without any sign of diminution.

The general average of sulphur impurities collected by all the thirteen London gauges in 1932–33 was 34·2 tons, as compared with 35·3 tons in 1931–32 and 35·6 tons in 1930–31. There has been, therefore, a slight reduction during the three years, and it will be interesting to note whether the operation of the Battersea Park new power station will lead to an increase again, when the returns for the current year are available. Gaseous impurities are more easily distributed over wide areas by air currents than solid impurities, and therefore any increase of sulphur impurity in London's atmosphere, resulting from the operation of the new super-power station, will be marked in all probability by an increase in the sulphur impurity collected by all the gauges, although no doubt the gauges nearest to the power station will show the largest increase. Solid impurities resulting from the operation of this plant, on the other hand, will be deposited chiefly on the windward side of the station, and it may be noted here that fine ash can be carried by the prevailing winds to immense distances, if the atmospheric conditions are favourable for its transport, before being deposited in recording gauges. The air pollution figures for London for the next two or three years therefore, will be, of unusual interest, for they will throw some light upon the efficiency of modern gas cleaning and washing plant, and may help to solve the problem of cheap electric power supply within the precincts of great cities.

Table IV. contains some figures showing the comparative amounts of sulphur impurity collected in other towns and cities for the three years ending March 31st, 1933. It will be seen that Southport and Bournville record the lowest figures of 14·2 tons and 16·6 tons respectively, and that Netherfield-road, Liverpool, and Ravenscourt Park, London, show the highest results, namely, 61·8 and 107 tons.

Table IV.—*Comparative Amounts of Sulphur Collected in Ten Towns and Cities of the United Kingdom During the Three Separate Years Ending March 31st,* 1933.

Town or city.	Tons of sulphur as SO_3 per square mile per annum. 1930–31.	1931–32.	1932–33.
Southport	16·4	12·6	14·2
Bournville	14·0	12·2	16·6
Birmingham Central	48·3	27·2	—
Glasgow (nine stations)	39·1	37·0	32·5
Leeds (Park-square)	38·5	40·0	34·3
London (eight stations)	41·1	40·6	41·3
London (Golden-lane)	47·0	45·2	46·8
St. Helens	40·0	46·5	38·9
Liverpool (Netherfield-road)	68·8	71·2	61·8
London (Ravenscourt Park)	105·6	104·6	107·0

Table V. contains figures for total solids and for sulphur acids at individual stations. Liverpool, Ashington (Northumberland), and Ravenscourt Park (London) head the list for both total solids and for sulphur, while Rothamsted, Marple, and Wakefield, followed by Southport, Bournville Village and Gloucester, form the cleanest group of towns, when judged by the amount of impurity collected by their most favourably located gauges.

Table V.—*Highest and Lowest Results in* 1932–33 *for Total Solids and for Sulphur Acids at Individual Stations.*

Highest and lowest results.	Tons per square mile per annum. Total solids.	Sulphur acids.
Highest results.		
Liverpool (Netherfield-road)	597	61·8
Ashington (High Market)	474	38·9
London (Ravenscourt Park)	472	107·0
Burnley (Town Hall)	454	27·8
Sheffield (Surrey-street)	372	34·0
London (Golden-lane)	344	46·0
Glasgow (Britannic Gardens)	292	39·0
Lowest results.		
Rothamsted	90	—
Marple	107	—
Wakefield (Clarence Park)	101	17
Southport (Hesketh Park)	113	15
Bournville Village	124	16
Gloucester	142	—

Welded Boiler Drums and Steam Receivers.

Mr. C. H. Davy presented a paper to the Institution of Welding Engineers, in London, on Wednesday, January 10th, dealing with the development of welding as applied to boiler drums and steam receivers. One of his objects was to show that the production of boiler drums and cylindrical steam pressure vessels by welding had been brought to a satisfactory commercial state, and was no longer purely the subject of experiment. The company with which he is associated is taking steps to obtain the acceptance of welded drums here, and already the first all-welded steam receiver in this country has been in service since the middle of last year, whilst a boiler drum having a diameter of 54in., suitable for a pressure up to 384 lb. per square inch, is being installed in Italy. Ten other welded drums are being put in hand at the works, of which three are destined for a vertical tube boiler in this country. Mr. Davy expressed the belief that welded drums would be taken up with much greater rapidity than might have been expected from a survey of the situation a year ago.

Mr. Davy summarised the arguments in favour of the introduction of welded drums as follows :—

(1) It is possible to retain the use of a rolled steel plate which represents a thoroughly worked steel, and can be put into the right condition of grain size before leaving the steel works.

(2) A welded drum can be produced with the same cross section of wall over the full circumference of the cylinder, or, in the case of thick and thin plate drums, the change of section may be gradual, so that high stresses due to sudden changes of cross section are eliminated. This is not possible in riveted drums where the presence of double-butt straps results in sharp changes of cross-sectional thickness and consequent bending stresses.

(3) The welded drum is lighter than the riveted drum, and cheaper than the solid forged drum.

(4) A welded drum may be stress-relieved by heat treatment after completion, so that it is put into working service with no other stresses present than those set up by the expanding of the tubes into the shell and the bursting pressure within the shell.

The weld metal must have physical and chemical properties similar to those of the parent metal, and to fulfil that requirement the micro-structure of the weld metal must be of a certain predetermined type, whilst means must be provided to replace in the weld metal the carbon, silicon and manganese lost, owing to the volatilisation of those elements in the arc. Upon that argument it became clear that coated electrodes had to be used in boiler drums, and that meant the development of special machines capable of feeding coated electrodes continuously without stopping and starting the machine at very short intervals for electrode replacement. Such machines existed, and the weld metal could be laid down within definite temperature limits so that the class of structure could be controlled throughout the welding operation.

From the engineer's point of view, the multi-layer weld was the most attractive. The comparatively thin layers of weld metal permitted the full flotation of slag before freezing, and suitable electrode coatings producing protective slag with a low specific gravity had been developed. Whilst the current density could be maintained sufficiently high to ensure good fluidity of weld metal and complete fusion, the section of the electrodes was such that it did not necessitate current densities of the class which brought about porosity. A further and most important safeguard against slag and lines of non-fusion was obtained by utilising the magnetic forces in the arc, together with a special electrode coating, so that the successive runs of weld metal, when deposited in the weld groove, took the form of a concave meniscus (water meniscus) with the walls of the groove, instead of the convex meniscus usually found in electric welding done by hand.

In a reference to the disturbed area in the parent metal immediately on each side of the weld, Mr. Davy said that there were many practical difficulties which prevented the normalising of the finished drum structure. It was not possible to heat the finished drum to a temperature of the order of 900 deg. Cent., in order to recrystallise the material. In addition, considering the weld metal, this recrystallisation would be undesirable, because the rate at which the whole mass of the drum could be cooled through the upper 400 deg. Cent. of the temperature curve would be such that a grain structure of very much coarser type would result in the heat-treated weld itself, and the laminar structure of the plate would lose the fibrous nature which made it particularly suited to carry circumferential stresses, such as the hoop stresses, &c., to which the drum was subjected in service.

With regard to the testing of the welds on drums, the author described a method whereby test plates were provided at each end of a longitudinal seam, the plates being tacked on prior to welding, and butt welded as part of the longitudinal seam of the vessel itself. They were afterwards heat treated with the drum to a temperature between 570 deg. and 620 deg. Cent., and then cut up into tensile test specimens, bend test specimens, all-weld metal tensile test specimens, and weld metal density test specimens, whilst impact test specimens might also be taken from the weld metal in those plates. Such plates, however, could not be produced when welding circumferential seams. Therefore, an X-ray method of inspection had been adopted, and the author stated that the development of X-ray technology as applied to that class of work had reached such a state of perfection that infinitesimal faults could be disclosed.

Finally, he stressed the grave necessity in this country for a strict and exacting code to which welded drums and steam vessels could be manufactured. Unless such a code were forthcoming, there was a great danger that unsatisfactory welded vessels might be placed on the market, with disastrous results. Welding could be entirely satisfactory if carried out under the strictest supervision and inspection.

In the course of the discussion, Dr. Dorey, of Lloyd's Register, suggested that at the present stage references to the superiority of welded over riveted drums were, if not rash, perhaps not well founded. Whilst one had a certain amount of confidence, he would suggest a pause in order to see how things developed. In this country, perhaps, the authorities concerned with making regulations had been a little behindhand, but that was not their fault, because until the demand for welded vessels arose, he did not see why authorities should make regulations. Lloyd's Register had approved different kinds of welded bodies, including boilers for land purposes—they were for use abroad—and other plants subjected to steam and air pressure. The insurance companies were likely to come down on Mr. Davy concerning his remarks on annealing. Dr. Dorey pointed out that the weight of metallurgical opinion was in favour of normalising, and when examining fractures in different classes of steel material it was remarkable how often one came across cases in which microscopical examination showed that the material had not been normalised. Rapid cooling from an upper critical temperature meant a certain amount of hardening, and where there were a number of small layers and rapid cooling there might be a differential hardening effect. Messrs. Thyssen normalised their welded drums, as also did Messrs. Pintsch, of Berlin.

Railway and Road Matters.

THE board of the Great Western Railway has appointed Sir Robert Horne as their chairman, as successor to the late Viscount Churchill.

IT is fifty years ago—on February 1st, 1884—since the London, Tilbury and Southend Railway Company completed its line from Southend to the terminus at Shoeburyness.

THE L.M.S. Railway Company has added to the Museum at the Derby Locomotive Works three models of older types of rolling stock of the former Lancashire and Yorkshire Railway. The models are, respectively, a wagon chassis, a non-corridor coach with four first-class compartments, and a composite carriage of 1894, having two first-class, two second-class, two third-class, and two lavatory compartments. The last-named model is the largest, being 6ft. 1¼in. over buffers, 13in. wide, and 18in. high.

WE again have to acknowledge the receipt from the South African Railways and Harbours Administration of its annual report. The present document, which is for the year ended March 31st, 1933, contains the first report of Mr. T. H. Watermeyer, who became the general manager on August 14th, 1933, after having acted in that capacity since February 1st. The revenue from railways for the year in question was £20,619,878, as against £22,039,659 for 1931–32, or a decrease of 6·44 per cent. Expenditure was £15,591,054, as compared with £17,604,116, a decrease of 15·44 per cent.

A VERY instructive letter from Mr. D. Ross-Johnson, a former Indian railway officer, and latterly of the Bristol Corporation Docks, appeared in *The Times* of January 22nd, wherein it was pointed out that the State had compelled railways to fence in their tracks and to provide signalling, shipping to have its Plimsoll mark, and factories their special safeguards. Mr. Ross-Johnson then proceeded to say: "No voice has ever suggested that these costs should be borne by the public. It is only the motor users who expect the safeguards, necessary in the circumstances, brought about by their own existence, to be provided by the community at large. Is this equitable?"

No less than eighty passengers lost their lives in train accidents in 1874—sixty years ago. A feature of that record year was that whilst three accidents led to 16, 21, and 34 persons respectively being killed, the remaining nine had only one fatality in each case. It was sixty years ago on January 27th since the first of the three serious disasters occurred. It happened at Bo'ness Junction, on the North British Railway, and was due primarily to the non-provision of the block system, and then to the driver of a passenger train overrunning his signals and colliding with some wagons that were being shunted. Additionally to the sixteen passengers being killed, as said above, one servant lost his life.

THE "Royal Scot" train, which, since January 1st, has been on tour of England and Scotland following its visit to the North American Continent, has proved such an attraction in this country that the L.M.S. Railway has decided to extend the "home" tour to embrace eight more towns. Originally planned to finish at Leicester on January 28th, the tour will now continue in February at the following places:—Southend (February 3rd to 4th), Llandudno (6th), Holyhead (7th), Southport (Chapel-street Station, 8th to 9th), Blackpool (North Station, 10th to 11th), Barrow (Central Station, 12th), Morecambe (Promenade Station, 13th to 14th), and Blackburn (16th). Over 500,000 people have now inspected the "Royal Scot" since it was first exhibited at Euston on its return from Canada.

AN unusual railway accident occurred on Monday morning, January 29th, in the Watford tunnel, when the L.M.S. Tring to London train, drawn by a standard 2–6–4 tank locomotive, had a narrow escape from disaster. As the train appeared to be travelling faster than usual when approaching Watford Junction Station, the guard applied the emergency brakes and the train was pulled up in the station. It was then found that the driver of the train had been blown or had fallen from the footplate in the tunnel owing to a burst smoke tube, which had also caused serious burning and scalding of the fireman, who had to be removed to hospital. The train was cancelled and a search party found the body of the driver on the permanent way within the tunnel. The accident will be the subject of a coroner's and a Ministry of Transport inquiry.

THE collision of January 31st last year, referred to by Mr. H. M. Lacey, in his letter on "All-steel Rolling Stock," which appeared in our issue of January 26th, was at Loughborough, and the speed of the express at the time of the collision was 25 to 30 m.p.h. The construction of the rolling stock was not mentioned in the Ministry of Transport report, but Colonel Trench did remark that the results of that collision again drew attention to the value of the Buckeye couplings in such circumstances. In passing we would like to make another mention of the useful service rendered by Buckeye couplings when accidents occur. On September 29th, 1931, a return special train from Newmarket Races had the points shifted under it at Digswell Junction, Welwyn, L. and N.E.R., and the six rear coaches were diverted by the change of the facing points and ran for about 270 yards on the up goods line with the engine and first three vehicles on the up passenger line; the leading bogie of the fourth coach was derailed, but the trailing bogie was on the goods line. The speed was 25 m.p.h. In his report Colonel Trench remarked: "It is difficult to imagine a derailment such as this one which could have resulted in less damage, and I think that the presence of the Buckeye couplers must be recognised as a very important factor in contributing to this fortunate result." The evidence given by Mr. Lemon in the Charfield inquiry as to why kitchen cars were exempted from the L.M.S. policy of equipping all newly constructed passenger stock with electric lighting was to the effect that "the company have found, after full investigation, that at present it is not practicable to use electricity for cooking as many as 200 meals at one sitting, which is their standard requirement, as gas alone can provide the heat sufficient for that purpose."

Notes and Memoranda.

AN experiment was carried out by the Industries Department of the Mysore State in the erection of a gas plant for generating electric power from lantana charcoal. The experiment yielded satisfactory results, inasmuch as it was found possible to generate electric power at a cost of about 1 anna per kWh.

A NOVEL and practical way of sealing the open end of a tube was recently given in *Popular Mechanics*. Drill a solid rubber ball through the centre and insert a bolt; then push the ball into the pipe. On the end of the bolt place a washer and screw down with a wingnut, and the ball will be squeezed snugly against the walls of the pipe.

THERE are several methods of removing broken taps and studs, some of which we have described in this column. The following way is given in *Machinery* by "W. E. W.," and is well worthy of attention. First procure a thin half nut and centre this over the broken tap. Finely powdered graphite should be sprinkled over the casting where the nut makes contact to prevent the two seizing together. Then, using an oxy-acetylene torch, with the hole in the nut as a target, weld the broken tap to the nut by means of bronze welding. This can easily be done, and if care is used the nut will be welded to the broken end of the tap only. Using a spanner of suitable size, the tap or stud may then be screwed out.

IN the course of a lecture on fire-fighting, before the Junior Institution of Engineers, Mr. E. C. Prince said that an inert gas, CO_2, stored in a liquified form under pressure, but released in gaseous form, is an effective extinguisher, clean, quick in action, and causing no damage. It has recently been adapted to extinguishing automatically and instantaneously films which have caught fire during projection. A mechanism is fitted to the projector from which pipes lead to vital points, such as the "gate" top and bottom loops and the spool boxes. The instant the exposed portion of the film fires, a fuse releases the operating mechanism of the extinguisher, and CO_2 is discharged throughout the film track in the fraction of a second, the electric current to the machine being at the same time cut off.

THE following particulars of an unusual pumped storage hydro-electric power plant being built by the Lamoka Power Corporation on Keuka Lake, New York State, are given in *Power*. A natural gas field is under the property, and gas is taken from it to operate four gas engine driven generators, having 6600 H.P. total capacity. A hydro-electric plant is adjacent to the gas engine plant. One 2500 H.P. hydro-electric unit is installed, and a 7500 H.P. unit is on order. There is one 8000 g.p.m. pump in service and two 16,000 g.p.m. units are on order. The hydraulic and gas engine plants are operated in parallel on peak loads. During off peak periods the gas engine units supply power for pumping water from Keuka Lake into Lake Lamoka, the latter acting as the storage reservoir for the hydro-electric plant.

A NEW heat and acid-resisting paint, known as Houghto-Kote, has been developed, available in five different colours. The base of the paint is a black fossil gum, which in its natural state is impervious to all commercial acids. In order to give the gum the consistency of paint, it is blended with a liquid vehicle at an extremely high temperature, resulting in a thorough fusing of all the basic elements. The paint is applied by brush and is ideal for the coating of boiler fronts, steam pipes, radiators, smoke-stacks, and other surfaces where the temperature would destroy ordinary paints. It is also suitable for use in buildings, such as dye-houses and chemical plants, where contact is made with strong alkaline solutions, and in pickling sheds using strong acids. In a slightly modified form, Houghto-Kote, it is said, can be used as a metal primer, as a paint for aluminium, and as a compound or paste which sets and forms a rubber-like coating on the inside of metal pickling baths, the material in all cases fully retaining its heat and acid-resisting qualities.

A BEARING, which is said to solve a large number of industrial operating problems and to increase largely the life and capacity of machines, called the "Nomy" bearing, is being manufactured at Ulvsunda, near Stockholm. It is a sliding bearing of the Michell type, but working independently of the direction of rotation, and is manufactured in the same standard dimensions as ball and roller bearings. The rotating bearing surface is composed of a series of blocks with a spherical surface, which adjust themselves automatically to the direction of rotation. The unbroken and continuous oil film thus obtained between the sliding surfaces of the bearing makes it possible, it is claimed, to carry loads many times greater than the usual bearings with parallel surfaces, while the friction is reduced to a minimum. The lubrication is automatic and each bearing is supplied with a complete oil sealing arrangement, eliminating leakage and preventing the access of impurities. One of these bearings is claimed to have been kept running uninterruptedly up to 20,000 hours without showing any signs of wear or fatigue.

THE Diesel Engine Users Association has presented its 1932–33 annual report on heavy oil engine working costs. This year returns have been received from only fifty-four generating stations, the number of home stations having dropped to thirty-four, while there has been an increase in the number of returns from overseas stations. Reports from nine waterworks plants are also incorporated. Mr. Wilson, of Ashford, states that owing to the tax on fuel oil the cost of their fuel has been increased by 40 per cent., and as this is not to be passed on to the consumer, fuel will cost about £1500 extra this year. The total output for the year was generated in the following proportions of the total:—155 engines of from 25 to 499 B.H.P. generated 26 per cent.; 50 engines of from 500 to 999 B.H.P. generated 20 per cent.; 35 engines of from 1000 to 3000 B.H.P. generated 54 per cent. The average fuel per unit generated for all stations was 0·648 lb. at an average running plant load factor of 67·2 per cent. Converted at the rate of 19,500 B.Th.U. per lb., this consumption corresponds to an average thermal efficiency of 28·9 per cent.

Miscellanea.

A SMALL submarine, 26ft. long, driven by electric batteries, and carrying a crew of four, is being tested by Japan.

AT a recent meeting of the Londonderry Harbour Board, it was announced that the Air Ministry has decided to form a seaplane base on the river Foyle at Londonderry.

THE total length of the railway system in the Soviet Union has been increased during the past fifteen years by 43 per cent., some 22 per cent. of which was accomplished in the years 1930–33.

UP to the end of last year £1,263,157 had been spent on the Victoria Docks road-widening scheme undertaken by the West Ham Corporation with the help of the Ministry of Transport.

ACCORDING to *The Times*, a shipment of 45 tons of Cellon aeroplane "dope" has been despatched to Turkey; the market in Turkey for aeroplane "dope" has hitherto been almost a monopoly of France.

AT an additional cost of £34,799, Southampton Harbour Board has approved proposals for extending the £240,000 dredging contract with the object of straightening as far as possible the deep-water channel approach to the dock.

IT is reported that an unusually large number of orders are being executed in boat-building yards in Plymouth, and one firm is building a 10-ton auxiliary sailing yacht, the first of her size constructed in the town for ten years.

THE death was recently announced of Mr. John Haworth, general manager of the Sewage Disposal Department and chief chemist and water examiner to the Sheffield Corporation. He was the inventor of the bio-aeration system of sewage disposal.

IT has been announced that Thames Board Mills, Ltd., is contemplating the purchase of two more cardboard making machines, comparable with the plant at Purfleet—described in THE ENGINEER of July 21st, 1933. That plant is capable of producing over 2000 tons of board a week.

THE St. Helens works of United Glass Bottle Manufacturers, Ltd., have, according to the *Chemical Trade Journal*, decided to return to coal for fuel. The furnaces have been heated by means of crude oil for some years. The firm will take about 100,000 tons of coal from the local collieries each year.

IT is announced that the Westinghouse Brake and Saxby Signal Company is making arrangements with the Polish Ministries of Finance and Communications for the installation of a continuous brake system on the Polish Railways goods rolling stock. The value of the contract is expected to be about £4,642,850.

AN international exhibition of the Air Post is to be held at the Horticultural Hall, London, from May 7th to 12th. This will be the third international show of the kind, but the first in London. One was held in Paris in 1930, and the second in Danzig in 1932. The main object of the exhibition is to popularise the use of the Air Mail, and to encourage the development of civil aviation.

AT a meeting in Glasgow, Mr. Fitzpayne, the chief technical assistant of the Edinburgh Transport Department, said that the main advantage of the electric vehicle over the motor omnibus was that the price of the fuel was not subject to violent fluctuations, but unless the electric energy could be purchased at a cheap figure, electric traction was bound to disappear in this country,

THE British canning industry created a record during 1933, when the output of cans for the canned food industry reached approximately 120,000,000. In 1923 there were only seven canned food factories of any importance or size in this country, and the cans they needed were supplied almost entirely by Germany and Belgium. Last year 82 British canning factories drew 93 per cent. of their supplies of tin-plate from home manufacturers.

A TEXTILE combine is being arranged in Central Asia, the first section of which comprises 111,000 spindles and 3264 looms, eleven calico printing machines, two scutching, and two bleaching aggregates. The estimated annual output of this section is 75 million metres of cotton fabrics. The first section of the combine is nearly finished; the second one is to be of equal capacity. The total cost of the entire plant is estimated at 112 million roubles.

ACCORDING to Mr. D. C. Durland, President of the Canadian General Electric Company, more than a third of Canada's thirty-five principal industries are 90 per cent. electrified, whilst twenty-seven industries have a ratio of more than 80 per cent. Canadian industry, as a whole, is more than 76 per cent. electrified. Many industries are practically 100 per cent. electrified, among these being the cotton, silk, rayon fabric, and rayon yarn manufacturing industries.

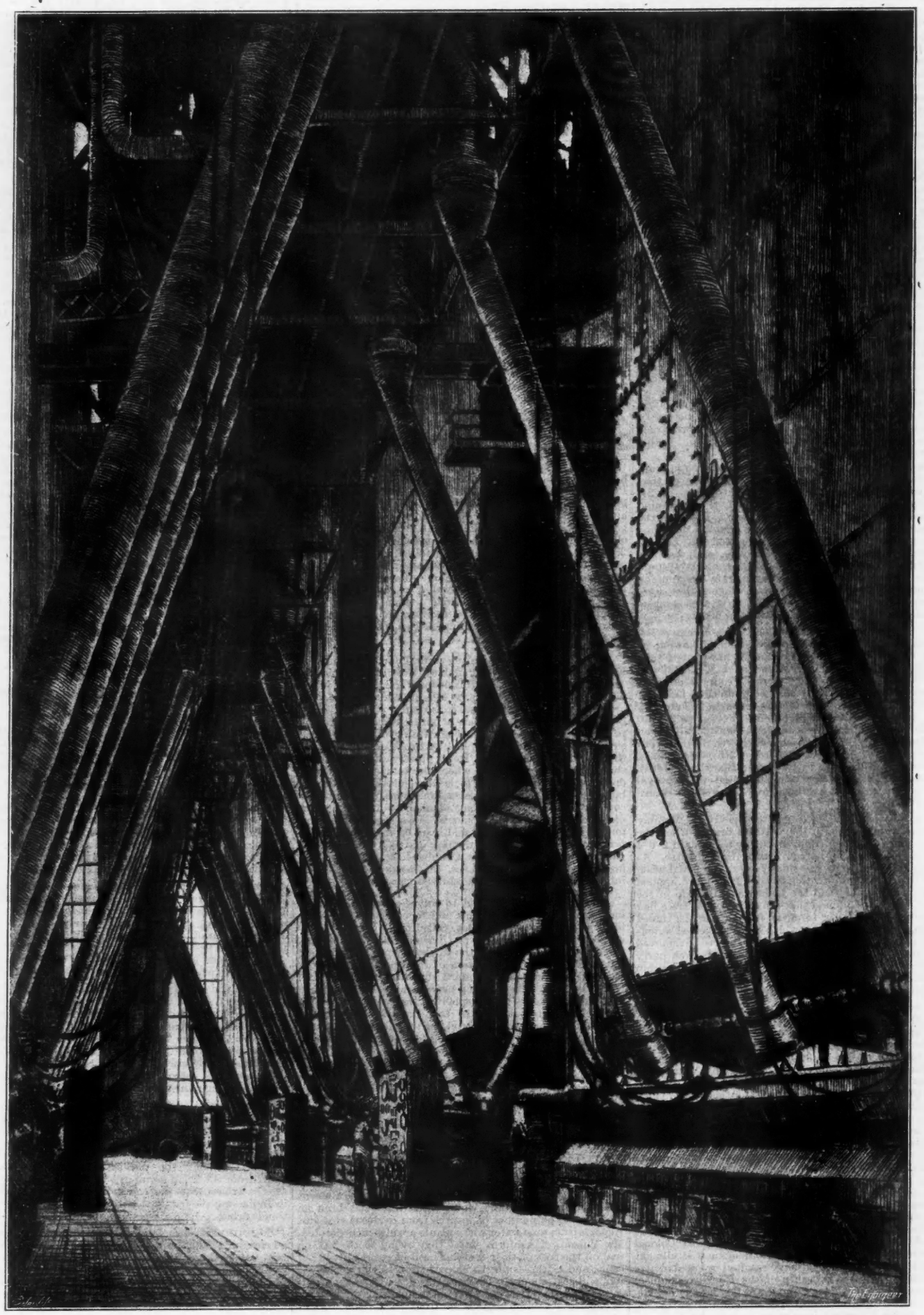
ACCORDING to a report in *Indian Engineering*, India, with a population of approximately 355,000,000, has only 57,000 telephones in use, or one to 6500 of its people. Even for the 30,000,000 inhabitants presumably able to afford a telephone this gives only one instrument to 526 persons. Among the reasons for this backwardness, apart from the small earnings of the masses of the people, are the 220 separate and mutually unintelligible languages in India, and the fact that only 10 per cent. of the population is urban.

SOMETIMES I despair of getting people in industry to go carefully, said Mr. R. Dennison to the Tees-side Industrial Safety Committee on Friday last, and pin the whole of my faith in what are called "fool-proof" devices, but much as I appreciate the importance of what has been done in this direction, and what can be done in the future, there are obvious limits beyond which it is not possible completely to protect the "fool" from the consequences of his folly. Hence we are thrown back once more upon the human factor and the free choice of the individual to walk prudently or take risks. Men get used to taking risks and think nothing of it, often regarding safety devices as a nuisance. They profess to believe in luck, which reminds me of the saying that "Fools believe in luck, wise men in destiny, and the pious in Providence."

THE NEW BARKING POWER STATION

MESSRS. MERZ AND McLELLAN, LONDON, CONSULTING ENGINEERS

(*For description see page* 115.)



INTERIOR OF BOILER HOUSE

(*From an original etching by C. H. Barraud*)

The Engineer

FEBRUARY 2, 1934.

VOL. CLVII. No. 4073

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TWO-PAGE SUPPLEMENT—THE NEW BARKING POWER STATION.

NOTICES TO READERS.

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DEATH.

ON January 30th, 1934, at Hessle, TOM WESTGARTH, of Richardsons, Westgarth and Co., Ltd., aged 81.

AUTOMATIC COMBUSTION CONTROL.

To most engineers interested in modern power station operation it must be a matter for regret that the discussion on Messrs. Hodgson and Robinson's paper at the Institution of Mechanical Engineers on Friday last developed along narrow lines and amounted in large measure to mutual criticism between the advocates of rival systems of automatic combustion control. There are many systems of automatic control available to the power station engineer. No fewer than thirteen different schemes are to be found described in the paper, all of which have reached the stage of practical application, principally in America, and have, according to their supporters, given satisfactory accounts of themselves. In view of this almost embarrassing diversity of means towards the desired end, it is evident that the advocates of automatic combustion control would serve their own interests better by trying to convince possible users of the general advantages of such control than by arguing over the details of their rival systems. The power station engineer, it can be asserted, is to-day quite satisfied that automatic combustion control can be achieved by a variety of methods. The precise details of the equipment are of relatively secondary importance to him. Of far more general interest at the present moment is the question of the value of the system in general, its advantages, practical and financial, and the extent to which they are, or may be, accompanied by disadvantages. It is undoubtedly believed in many influential quarters that the benefits of automatic combustion control have not yet been sufficiently established, and that its disadvantages have been minimised. Last Friday's paper and discussion did singularly little to clarify these major issues.

On the general question of the gains to be realised by the adoption of automatic control, a wide divergence of opinion and of evidence exists. Among the manufacturers or designers of control systems there would appear to be uncertainty, not only as to the amount of the gains, but also as to the field in which they lie. At the Hackney station two consecutive tests, each extending for a week, were made, the first being carried out with the automatic control system in full operation, and the second with the automatic features temporarily suppressed in favour of manual control. The results showed an efficiency of 84 per cent. for the automatic control and of 78·1 per cent. for the hand control, corresponding to a saving on the three boilers fitted with the system of over £10,000 a year. These figures, however, tell us very little. They are but items in the complete economic balance sheet which to be fully enlightening should contain entries for interest charges and depreciation, cost of running, and so forth. Even, however, if all the relevant figures were available, it would still be unsafe to found on them a general opinion as to the financial advantage to be gained by the adoption of automatic control. Mr. Robinson, the Hackney Borough electrical engineer, himself admitted that he had some doubts as to whether the two tests were carried out under strictly comparable conditions. At Hell Gate station the saving effected by the adoption of automatic combustion control is stated to have amounted to only 1 per cent. At another American station the same system of control is reported to have yielded a saving of 11 per cent. Three other stations are said to have exhibited savings of 3·2, 4, and 6 per cent. Mr. Cater, an advocate of automatic control, in giving these figures at the meeting, provided what is doubtlessly the true explanation for their wide variation. The saving effected obviously depends upon the efficiency with which the plant is operated before automatic control is adopted. The Hell Gate plant was previously run very efficiently, and all that automatic control could do was to raise the efficiency by 1 per cent. The Lowellville station, on the other hand, was operated under such conditions that automatic control found scope for an improvement of 11 per cent. in the efficiency. In Great Britain another system of automatic control is reported to have shown savings of 10 to 15 per cent., and in one case of as much as 28 per cent. Mr. O'Breen, on whose authority we quote these figures, admits, however, that at the stations which returned them the previously used system of hand control left much to be desired, and that in a well-operated plant the adoption of automatic control can be expected to increase the efficiency by only 2 to 3 per cent. It is, however, by no means established that the financial saving is the sole criterion by which the advantages of automatic control should be judged. On this point much too little was said at the meeting. But from a passage in the paper it is to be inferred that at least one advocate of automatic control does not see in it merely a means of saving money, and that insistence by possible users on that aspect of the subject is to be deprecated. It is argued by Mr. Hodgson that combustion control devices were first developed to prevent the production of smoke, then to ensure the maintenance of the steam pressure without continuous close attention on the part of the stokers, next to maintain a balanced draught, and, finally, to facilitate the control of large boilers and groups of boilers. It was only when these things were achieved, says Mr. Hodgson, that engineers demanded that automatic combustion control should give the highest possible efficiency for the lowest possible operating costs. It may be argued that the attainment of these objects was in the main inspired by an ultimate desire to save money. For example, except in so far as it is an offence punishable by Act of Parliament or under local by-laws, the emission of smoke might well be tolerated by power station engineers were it not for the fact that such emission is a sign of incomplete combustion, and therefore of financial waste. Nevertheless, there are undoubtedly many respects in which automatic control might be advocated as desirable, not merely on the ground that it achieves a financial saving, but because it permits to be done that which otherwise, and at any cost, could not be done.

Of the disadvantages attending, or alleged to attend, the adoption of automatic combustion control, that which received chief attention at the meeting is probably one of the least important. The complexity of the equipment required to give complete control may strike the observer at first sight as providing a serious item for criticism. It is not altogether reassuring on this point to be told that the electrical connections and other details included in the equipment are not complicated to an electrical engineer conversant with automatic telephone exchange practice. It is open to us to reply that the conditions in a boiler-house are as different as they well could be from those in a telephone exchange. We need not, however, rely on such an extreme analogy. A general acquaintance with the trustworthiness of modern materials and methods of construction justifies us in placing faith in soundly designed mechanisms, however complicated they may be or appear to be. Complexity, by itself, is no longer a bogey to the engineer. Another objection urged by the critics of automatic control seems to us hardly more well-founded. It is argued that as it reduces the number of attendants required in the boiler-house, it increases the confusion and disturbance caused by a failure or breakdown. Much might be said on that point, but it is perhaps sufficient to remark that precisely the same argument might be developed against many labour-saving methods and appliances which engineers have devised and adopted. It might, for example, with equal force be applied against the use of mechanical stokers and as a reason for adhering to hand firing. The real disadvantages of automatic combustion control have, we believe, not been sufficiently debated. It has been asserted, for instance, that it provides no means of controlling the temperature of the steam. No enlightenment on this point is to be derived from last week's meeting, except that contained in a completely unsupported statement by Mr. Hodgson that "combustion control tends to ensure more uniform superheat." Again, it has been suggested that automatic control imposes very severe conditions on the refractory linings of the combustion chamber. Here, again, we are faced with Mr. Hodgson's statement of directly the opposite import. Automatic control, he asserts, protects the refractories by preventing undesirable firing conditions, and by way of evidence he tells us that at Hackney the refractories have not been renewed since the boilers were started in May, 1932. It is obvious that the advocates of automatic control have still some way to travel before they can expect to see it accepted generally as a desirable addition to the machinery of the power-house. They have a case which in many respects is a strong one, but at this stage they will inevitably weaken it in the eyes of their possible clients by public and unrestrained criticism of the details of their respective systems.

Agricultural Engineering.

THE outlook for the agricultural engineering industry is brought into clearer perspective by the annual show of agricultural implements and machinery recently held in Paris. The importance of what is a great international gathering is increased by its being held in a country which is primarily agricultural, and has always offered a market for foreign agricultural engineering products. While, however, the deductions drawn therefrom include elements of appreciation regarding the future of the industry, they do not remove the uncertainties arising out of the economic difficulties which have proved particularly disastrous to agricultural engineering. From the point of view of foreign trade, the industry suffers probably more severely than any other. It is directly affected by the heavy slump in world prices, and it cannot recover until an advance in the values of produce enables farmers to buy the machinery they need. The situation of British exporters is further complicated by the development of the agricultural engineering industry in Continental countries that were formerly markets for British implements and machinery. So considerable has been the growth of the industry abroad that the foreign trade outlook for British makers would be precarious if it were not for the difficulties experienced by competitors across the Channel, who affirm that their future can only be saved by a restriction of imports. Quotas are already applied in France to the imports of grist mills, tractors, and some other machines, but they do not affect harvesting machinery, except indirectly through the quotas for spare parts, which tend to limit the possibilities of selling new machines. This is, at the present moment, one of the critical points at issue in the trade discussions between the two countries. Any attempt to restrict the importation of farm machinery into France is opposed by the agriculturist, who will not accept any measure of an economical or fiscal character which will increase the cost of machines required in his industry. This attitude will always exert a restraining influence upon attempts to exclude foreign machinery for the benefit of home manufacturers, but some restriction will doubtless continue until such time as all nations adopt larger views of international trade

than they entertain at present. The farmer's view of the necessity of competition as a means of keeping prices at a reasonable level will, nevertheless, tend to widen Continental markets for British machinery, and it is not unreasonable to suppose that some foreign makers who declare that they are unable to continue the manufacture of some classes of machines under present conditions, unless they are sufficiently protected from outside competition, will have to confine their business to less competitive products. One of the largest firms in Germany has recently abandoned the manufacture of harvesting machinery. The tendency at the moment is to eliminate manufacturers who are unable to exist in the face of competition, and also to develop new branches of agricultural machinery production which are the immediate outcome of changes in agricultural methods.

Agricultural engineering will rise again upon the ashes of a ruined agriculture. No other term is applicable to agriculture abroad, where the situation of farmers is desperate. They are obliged to look to other ways of making the industry profitable, and except in countries that depend upon grain exports there is taking place a transformation in agricultural practice that needs to be closely watched by the agricultural engineer. The wheat-growing areas are being reduced on account of the stocks of grain held over from previous years, and more is being done with the intensive cultivation of medium and small farms. Costs must be reduced, and this is only possible with the aid of the engineer. How these changes will be continued in the future depends upon what will result from the efforts to reorganise international exchanges. Whatever happens, the agricultural engineer is prepared for every contingency, and at the Paris Show there was little wanting that would not satisfy eventually any change in agricultural methods. The problem really resolves itself into providing all classes of farmers, down to the smallest, with the same mechanical facilities that have enabled big growers to cultivate territories that would have remained unproductive for all time without the use of machinery. It is for this reason that tractor developments are particularly interesting. For medium-size farms the tractor has fallen into line with standard types, fitted with heavy oil engines, and judging from what was seen in Paris, there is a prospect of the pneumatic tire coming into more general use. The tractor does not appear to have completed its cycle of evolution, for a German machine with six-speed gear, self-starter, and electrical equipment, suggested that the cycle would be completed by the adoption of the conveniences of the motor car. For years past engineers have sought to meet the needs of small farmers for light power machines and motor implements, and the numerous applications of this kind at the Paris Show revealed undeniable progress and a prospect that, in a comparatively short time, it will be possible to equip the small farm as efficiently as big estates. The problem offers difficulties which are being gradually overcome. The practice of fitting auxiliary engines to binders and grass-mowing machines, the use of small two-wheel tractors for tillage, and various mechanical appliances that facilitate small farm operations, provide possibilities in light agricultural motor machinery that open up an interesting field to the agricultural engineer, though doubtless without much prospect of immediate results.

Until something is done to unravel the tangle of economic complications, and prices allow Continental farmers to put their industry in order, the opportunities for improving foreign trade in agricultural machinery will continue to be limited. It was therefore all the more interesting to learn that English makers at the Paris Show are in a good position to profit from any improvement that may arise, if only they are not excluded from the French market by the reduction of quotas that was instituted at the beginning of the year. Their experience until then had been encouraging. Now that the pound has found its level, the reputation of British agricultural machinery on the Continent should enable the industry, under normal competitive conditions, to regain its former ascendency, in the same way that British engineers should eventually benefit from what appears likely to be an expanding market for light and economical motor farm machinery.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE DEVELOPMENT OF THE PARSONS STEAM TURBINE.

SIR,—I was one of the engineers of the Manchester-square station when the first turbines were installed there. The high-pressure portion was considerably the longest, and this perhaps was a good thing, as the second expansion blading often suffered from what we then learned was the "whipping" of the shaft. This did not worry us very much, as it was a simple matter to cut out the damaged blading, close up the set, and continue working. Sometimes nearly one-third of the total blading would be cut out, but the remainder was quite sufficient to help us through the time of heavy load. We were also able to demonstrate what was the effect on the output after losing 50 per cent. of the blading, as we had at this time an unlimited quantity of steam.

In twelve or eighteen months after the first turbine was put on commercial load we had gradually eliminated most of the difficulties, and when the heavy load come on in the winter we found the advantages of using turbines as compared with the reciprocating engines. With the reciprocators, if a small quantity of water came over with the steam, it generally meant damage to the central valve trunks and distance pieces, which took some considerable time to repair and was very costly. With the turbine, when we had a partial strip, we generally ran on to the time when it was possible to disconnect the set from the supply, lift the cover, cut out the damaged blades, and have the set ready for running by the next evening's load. At this time we had a double shift of bladers, but it was so necessary to run the turbines rather than the reciprocating engines on account of the vibration caused by the latter, that the bladers could only get at their work at stated times and at the week-ends.

At times, owing to the turbine spindles and the rotating armatures of the alternators getting out of balance, we had some little bearing trouble, but with the concentric bush bearing and the tubes that acted as sleeves over it, it was a very rare thing for the spindles to seize. When they did, the shaft broke at a nick cut for that purpose in the square end which entered the coupling, and no further damage was done. The provision of a nick was abandoned later, as it sometimes caused the shaft to break when there was no necessity for it. Very little scouring of the spindles occurred, and when it did, it could nearly always be put right with a lapping tool. Even with the somewhat frequent hot bearings, no wear could be measured on the diameter of the bearing bushes, and the number of renewals was not in any way a serious matter.

It was a most extraordinary thing how long it was possible to keep one of these turbines going when a hot bearing occurred. The driver used to cover the bearing up with cotton waste and we had a cold water circulation which kept the waste wet. Perhaps, after an hour or more, the bearing was still heating with a quantity of smoke coming out. We then used heavy cylinder oil, and this either had the effect of cooling the bearing down, or else the smoke became so great that we could not live in the engine-room.

After a breakage of a turbine shaft, as mentioned above, as a quick and temporary method of repair, the larger diameter of the shaft was drilled out and a hard steel spindle forced in by hydraulic pressure. These spindles were not satisfactory, as they became loose after a short time, probably on account of expansion by heat and excessive vibration. They became, moreover, fatigued very quickly, and developed such brittleness that it was possible to fracture them with a slight blow from a hand hammer. With this experience, the spindles were made of softer material and the difficulty was entirely overcome.

The full-load steam consumption of the reciprocating engines was about 28 lb. to 30 lb. per B.H.P. hour. The statement of "steam per kWh" was not much used in those days, possibly because it made the consumption appear higher. It must be remembered that the consumption figures for the engines referred to full-load conditions only, the half-load consumption being about twice as great, since, with a triple-expansion engine running at half-load, the low-pressure cylinder is doing no useful work. We were told, of course, not to run the reciprocators at half load, but what could be done when, at four o'clock on a winter afternoon, we started with a head of steam of 160 lb.—10 lb. more than the normal pressure—and by eight o'clock the pressure was down to nearly 100 lb. per square inch? And this, in spite of the fact that we had a forced draught fan capable of giving a pressure of nearly 4in. w.g. under the grates, and at times the flames could be seen coming out of the top of the 120ft. chimney!

It would be interesting to know what were the leaving losses of the boilers under such conditions. It may be mentioned that the lining of the flues was burned out, and the supports that kept the exhaust pipe on the centre of the chimney were all found at the bottom in a confused mass. The exhaust pipe sagged to the side of the chimney, but did not break, so that the station could continue to be operated.

The turbines showed up to advantage when working with a falling steam pressure, as they would carry the load till the pressure fell to about 120 lb. After this point, when the steam relay ceased to function, it was a common practice to hold the relay valve full open with a cork, or by tying a weight on to the starting lever. By such means a continuous flow of steam passed through the turbine, which enabled the latter to maintain the voltage under conditions when the reciprocating engines would have been useless, for want of steam pressure. As regards the efficiency of the turbines, it was said that they used about 60 lb. of steam per kWh, but this figures was probably on the high side. In those days the question of continuous running was much more important than that of steam consumption, and, considering the great advantage of the turbines over the reciprocating engines on light loads, the commercial efficiency of the turbines, taking into account coal, water, stores, repairs, and renewals, was higher than that of the engines. I well remember that, after twelve months' working, the company's auditors showed that the total cost of running the Manchester-square station with turbines was less than it had been in previous years, when the reciprocating engines only were in use.

The original alternators had surface-wound armatures with the conductors held down by piano wire binding. These bindings were wound on in bands of from 4in. to 6in. wide, with a gap of about an inch between the consecutive lengths. The end caps were made of brass, and the leads were taken out to slip-rings, from each of which the current was led away by two brushes. The armatures heated up considerably, and frequently the piano wire fractured and was forced out at the ends of the machine. At such times there was a lot of wire whipping round each end of the armature and a good deal of fire flying about. After one or two burn-outs, the men in charge got to know by the variation of the hum of the machine when a burn-out was likely to occur, and a man was then kept at the stop valve ready to shut down. No one else was allowed to be near.

These surface-wound armatures were soon discarded and replaced by tunnel-wound armatures, but even these did not stand the many short circuits that occurred on the distribution system. During a heavy thunderstorm one or other of the sixty or seventy feeders going out from the station generally shorted, and the rule was to replace the fuse once before cutting out the defective feeder. This repeated the short circuit on the armature. At other times it was necessary to burn out a cable which was only slightly defective, a practice which put a considerable overload on the machine. We had some five or six spare armatures, though at times there were only one or two of them available for service. The damaged ones were returned at first to the Heaton works, but as they could not repair them fast enough to please us, we afterwards rewound them on site. The conductor was in a single length, so that by the time it had been drawn through all the tunnels the insulation near the end had become considerably frayed. At one time we encouraged the winder by giving him a bonus if his armature would stand up for twenty-four hours, as this did not always happen. If we got over the first two or three days, we expected the armature to last a month or two. But, like the difficulties with the turbine, after eighteen months or so all these frequent breakdowns came to an end, and we had a comparatively easy time until a short circuit occurred at the back of the main switchboard. This burned out the switchboard and the engine-room and boiler-house roofs. Twenty-two fire engines were playing water over the turbines for about four hours, but by the following morning we had obtained from the Great Western and other railway companies sufficient tarpaulins to shelter the turbine-room, and as the steam pipes had not been damaged two of the Parsons sets were arranged to supply current to feeders directly connected to the alternator slip rings and were put into service again by this means the same evening. The remaining load was taken by the interconnected stations.

C. A. HOLBROW.

January 29th.

SIR,—Your articles on this subject are of great interest, but to me they are particularly interesting, as I was at Manchester-square station and, indeed, at some other of the metropolitan electric supply stations during the years 1896–99. In the cause of historic accuracy, I would point out that the photograph, Fig. 17, is not Manchester-square.

It represents Sardinia-street station, where the turbine-room was over the boiler-house. Part of the floor was made with Hayward's floor lights, one of which is shown, to give some measure of light to the boiler tops.

The original boilers at Manchester-square did not have superheaters, but in the autumn of 1898 three additional boilers were put in and these did have very small superheaters.

The turbos at Manchester-square did not have Hartnel or any other rotating governors.

Other matters which I think are incorrect are:—Sardinia-street was equipped with turbines almost simultaneously with Manchester-square; indeed, I have always thought that the first turbo was at Sardinia-street, though I have no personal knowledge of that, and I may be wrong.

Amberley-road in my time had no turbos, the plant was (?) Fowler horizontal cross-compound engines with rope-driven alternators.

Willesden had for its first sets (U.S.A.) Westinghouse

vertical cross-compound engines, with the alternators between and they were followed by Sulzer marine type engines. There my personal knowledge and evidence finishes.

W. A. TRITTON.

Lincoln, January 23rd.

THE LOOKER-ON.

SIR,—I have read with interest your comments, under the heading of "The Looker-on," on Mr. Hunt's account of some improvement made by the National Institute of Industrial Psychology in an electrical repair shop. "It is astonishing," you state, "how often we require someone else to point out to us the obvious," and you refer to the Institute's work as an example. But such things become obvious only after changes have been recommended. Time after time the Institute has proposed changes in methods and conditions which a factory manager has watched day after day for years. Can a thing be called "obvious" if it has escaped the attention of a man who has been in close contact with it for years? Once a change has been pointed out to him, he may realise its value at once, but that does not make the change obvious. In fact, these "obvious" improvements are very often apparent only to an "outsider" who has been specially trained to look for them.

It is obvious to us, for example, that tidiness is really only one aspect of these changes. There are so many kinds of tidiness. As you say, a housemaid can tidy a bench, but her tidiness would probably be infinitely worse than the original untidiness. One knows only too well what happens when a maid tidies one's desk or papers—one wastes hours in searching for things, instead of the minutes one would waste through the apparent untidiness.

The first consideration in Mr. Hunt's problem was not tidiness, but accessibility of tools and material. He introduced order to the benches, but he did it by providing properly designed tool racks and storage places (not merely "a few shelves and racks"), which would save the worker the necessity of wasting time in searching among a miscellaneous litter of tools and materials.

I fully agree with you that there is much to be done in this and in many other ways in most works, but there are few managers who have the training or outlook, and still fewer who have the time to do it. The fact that the Institute's investigators are "outsiders" is one of their great advantages, for they can approach problems without any of the preconceived ideas which must inevitably bias a factory expert. They are unhampered by traditional ways of looking at things. They are not so used to a particular method that they cannot see its weak points. They can take a detached attitude. Moreover, they have the time for experiment and for testing new ideas. Unlike the factory management, they do not have to attend to a thousand and one other routine matters.

A suggestions scheme would never have replaced Mr. Hunt's work in this shop. It might have revealed the waste of time which resulted from disorderly benches. It might have produced the opinion that racks and shelves were necessary. But Mr. Hunt's designs were the results, not of opinion, but of careful experiment. He was not satisfied by just a rack—he wanted the best, the most suitable rack.

GEORGE H. MILES,
Director, National Institute of Industrial Psychology.

Aldwych House, London, W.C.2,
January 25th.

INVENTORS AND INVENTIONS.

SIR,—My birthday was celebrated very aptly by the Institution of Mechanical Engineers discussing their paper on the "Evolution of Invention." Much has happened since I wrote you last, many years ago, on this most alluring of subjects. Though it is, indeed, the master key to successful commerce, I feel that it has not been dealt with by the masters of men. To-day I am employed as a fitter, and on the whole a nonentity in the engineering world of Great Britain, but there is yet history to be written as ghastly as any that adorns the pages of yesterday, where originality, invention, and persecution go hand in hand.

Nineteen-thirty-four is as dangerous an age as was ever 1834 or 1734. Mr. Benton (page 100) gives you good advice, but understates the case—"for one such man, there are 10,000 who are merely improvers and adapters." From the million engineers that we may have in this country to-day, where is the man who can produce a rotary pressure engine, steam or I.C.? Where is the man who can fly with his own power? Where is the man who can put a couple of knots on the 534 "with the original" lay-out? Where is the man who can state clearly and indisputably the theory of forward impetus in soaring flight? Where is the man who can prove that the present trend of aircraft design is wrong? Where is the man who can propound a universal religion for all men and for all time? Where is the man who can prove that our railways, our ships, and our aircraft are power wasters of the first magnitude?

With all our vaunted scientific achievements and instruments, we lack a knowledge of the first principles of transport—displacement at speed. All through your various articles dealing with invention there is reflected the degrading taint of financial gain as the great incentive to creation.

The world's master men had no thought for wealth, the burning fires of enthusiasm has kept them from their bed and their table. Wives and families have either been forgotten or forced to contribute to the materialisation of the all-absorbing dream.

As a philosopher to-day, I realise exactly why and how national assets of this kind have been ruined, persecuted, and hounded to the grave.

I am sorry if I have put this crudely, but time is limited, both for you and me; for that reason I will conclude by asking you to accept the enclosed little book, "Treasures of Truth"—"a selection of thought-provoking aphorisms"— and the few graphs. They are typical of the efforts of an original mind and the spare-time efforts of a working engineer.

MCKINLAY HARGREAVES.

Reading, January 29th.

ALL-STEEL RAILWAY COACHES.

SIR,—Mr. Lacey suggests that bias in favour of all-steel carriage stock is shown by certain opponents of timber or composite construction. If a desire to expedite progress based on disinterested conviction is bias, then Mr. Lacey is correct.

In referring to the zigzag derailment of the L.N.E.R. main line stock on January 31st, 1933, he agrees with the contention in my previous letter. This stock embodies many of the features of modern all-steel carriages, as it is fitted with sturdy steel underframes, automatic centre couplers, sprung vestibules, and stiffened body ends.

Possibly, however, when Mr. Gresley first employed centre couplers and sprung vestibules he ran a risk of accusation of being a young man in a hurry.

The adoption of steel body construction may have been delayed by reason of the existence of extensive woodworking plants, but there has been a gradual move towards all-steel construction, as the G.W.R. and the L.M. and S. railways have adopted a composite construction of steel panelling on timber framework and the L.M. and S.R. has a number of all-steel carriages in service.

I agree that, apart from the L. and N.E.R., gas is still in general use in this country for cooking in dining cars, but this does not apply to overseas railways. The number of dining cars in use, however, is small compared with the number of other cars in service on which electric lighting is standard.

If Mr. Lemon stated that electric cooking was impossible, he obviously had in mind the present-day requirements of the L.M. and S.R. services only.

It was at one time suggested that climatic conditions in this country were unsuitable for all-steel carriages. If this suggestion were correct it no longer holds good, as supplies of corrosion-resisting steels at low prices are now available from British mills.

The carriage building firms in this country have had ample experience of the manufacture of all-steel stock, mainly for overseas railways, and are generally well equipped for such construction.

It has been proved that all-steel carriages are not inferior to wooden carriages in quiet running or in comfort.

Given two lengthy structures, one in steel and one in timber to resist an equivalent load, the steel structure would be lighter and much less bulky and would tend to cripple and not to disintegrate under excessive load or shock.

Whilst there remains any possibility of fire following a collision, fire-proof construction is to be desired.

The capital outlay on all-steel carriages should be lower than on wooden carriages, as the manufacturing cost should be cheaper.

S. R. DEVLIN.

Burton-on-Trent, January 28th.

ELECTRIC LIGHT FAILURES IN HOSPITALS.

SIR,—Referring to the recent electric lighting "black out" in North London, while it is gratifying to learn that in some of the hospitals emergency lighting sets were put into operation, it is disconcerting to read that in others only electric torches, candles and lamps were available.

I respectfully submit that the all-too-frequent failure of public electric supply emphasises the vital importance of the installation of automatic emergency electric lighting sets in institutions and public buildings, and particularly in all hospitals, where human life may depend upon reliable lighting.

ALFRED WARBIS.

Martock, January 27th.

SCANDINAVIAN SECTIONAL MEETING OF THE WORLD POWER CONFERENCE.

SIR,—Our attention has just been drawn to the leading article in your issue of January 19th, entitled "Science and Sociability," in the first paragraph of which you refer to the papers at our recent Scandinavian sectional meeting having been "so numerous and the social engagements so manifold that it was well-nigh impossible to get down to serious work."

We admit that it has not yet been found possible to reduce the number of papers presented at our meetings to the extent that we should wish, although considerable progress has been made in that direction. But the disadvantage of having too many individual papers was largely nullified by the fact that the great majority were circulated to intending participants well in advance of the Conference, and that the discussion at the technical sessions was in the main based on the general reports, in which the groups of papers dealing with the same and similar subjects were summarised.

To the second complaint, namely, that there were too many social functions, we plead emphatically "not guilty." Those who attended the Scandinavian Conference experienced that charming hospitality for which the northern countries are justly famed. But the formal entertaining was limited (so far as the bulk of the participants were concerned) to dinners in each of the three capitals. These dinners cannot be considered in any way to have interfered with the due execution of the technical programme; nor can the less formal functions which occupied the week-end.

C. H. GRAY,
Secretary, International Executive Council.

London, W.C.2, January 29th.

SIXTY YEARS AGO.

IT is still, we hope, fully understood by all our readers that the publication of an article in our columns cannot be secured, or the tenour of the opinions expressed in an article be influenced in any way, by payment or other consideration offered to us by interested parties. Sixty years ago this fact was not generally understood, and driven by repeated attempts to suborn us we administered a sharp rebuke to all concerned in our issue of January 30th, 1874. A certain gentleman—we need not recall his name—had written a book entitled "Hydraulics of Great Rivers: The Parana, the Uruguay, and the La Plata Estuary." He sent us a copy for review, and with it a note asking us to devote some attention to the subject of his work, which, he thought, would prove of benefit to hydraulic engineering. Under the heading of "A Mistake," we published this seemingly innocent note. The mistake was on the author's part. Accompanying his note he had enclosed a cheque drawn in our favour. This deliberate attempt to buy our good opinion aroused our indignation, and caused us to speak in terms to which injustice would be done by attempting to paraphrase them. We give them here in all their original forcefulness: "The author of 'Hydraulics of Great Rivers' is informed that his work, a copy of which we received a few days ago, will, in due time, receive the attention which, according to our judgment, it may merit; and, further, that the cheque drawn in our favour which accompanied his note has been forwarded by us in the name of the author of 'Hydraulics of Great Rivers' to the Treasurer of King's College Hospital, in aid of the funds of that praiseworthy institution. We have had so frequently to return to the senders bank-notes and cheques, and even shares in public companies, offered to us as inducement for the introduction of matters into, or the expressions of opinion in our pages, that to save trouble to ourselves and unpleasantness to others, we beg publicly to state that we shall record in these columns the name and address of every person who may in future think proper to make to us offers of this character which, however flattering they may seem as indicative of the influence of this journal, are as offensive to us personally, as they would, if accepted, be degrading to the character of THE ENGINEER. We are always ready, without fee or reward, to receive from any one information or contributions likely to be of value or interest to our readers, and are obliged to those who help us in this way; but we take leave, once for aye, to inform those whom it may concern that our opinions are not to be purchased, and that it is our purpose to maintain that perfect independence and impartiality without which journalism becomes a calamity instead of a benefit to the community." It need only be added that five weeks later we published a review of the book without making the slightest reference to this incident. The review extended to the unusual length of 4½ columns. On the whole, it was unfavourable.

OBITUARY.

FRANCIS HENDERSON.

MARINE engineers and naval architects alike will learn with deep regret of the death, in his seventy-eighth year, of Mr. Francis Henderson, which took place on Wednesday, January 24th, at Folkestone. Mr. Henderson was for many years the Treasurer and an Honorary Vice-President of the Institution of Naval Architects, and his personality and charm of character endeared him to all with whom he came into contact. For a period of over half a century he was associated with the Anchor Line (Henderson Brothers), of Glasgow, and he saw service for his firm in New York, Glasgow, Liverpool, and London. His services in connection with shipping interests and public administration were many and valuable. Mr. Henderson was a member of the Clyde Navigation Trust and the Clyde Lighthouses Trust, and a Chairman of the British Corporation Register of Shipping and Aircraft, in the affairs of which society he played an important part as an Honorary Vice-President. He was a Liveryman of the Worshipful Company of Shipwrights and the Second Master.

SPEAKING before the South Wales Section of the Society of Chemical Industry recently on "The Hydrogenation of Coal," Dr. W. Idris Jones, research manager of the Powell Duffryn Steam Coal Company, Ltd., said that owing to its high oxygen and low hydrogen content and unsuitable chemical structure, the yield of oil by the cracking of coal was small. Thus high-temperature carbonisation would yield 6–12 gallons, and low-temperature carbonisation about 15–20 gallons per ton of coal carbonised. Hydrogenation, however, gave up to 200 gallons of petrol per ton of coal treated. The early work of Tropsch, Berthelot, and Bergius had been enormously developed, especially since 1929, in consequence of the use of vertical reaction vessels, multi-stage processes, continuous reaction, and selective resistant catalysts. Every outlet for coal was a national asset, measurable not merely in terms of pounds, shillings, and pence. The National Government was to be congratulated on its far-seeing policy in granting a subsidy of 4d. per gallon to motor fuel produced in this country by coal hydrogenation.

Automatic Combustion Control.

INSTITUTION OF MECHANICAL ENGINEERS.

ON Friday evening of last week, Mr. J. L. Hodgson and Mr. L. L. Robinson presented before the Institution of Mechanical Engineers a paper entitled "The Development of Automatic Combustion Control Systems for Industrial and Power Station Boilers." Mr. Hodgson, it may be remarked, is a member of the staff of Messrs. Geo. Kent, who supplied the automatic control equipment for the Hackney Borough Council's station, to which Council Mr. Robinson was electrical engineer until last week, when he retired from that post. The paper is of very considerable length. It includes descriptions of the details of thirteen different systems of automatic control for boilers. Elsewhere in this issue we reprint a summary of it and, in full, that portion of it in which the Kent system as applied at the Hackney station is described.

Mr. Newton Booth, opening the discussion, said that the size of boiler units in modern power stations made the advantages of automatic combustion control more apparent than in smaller industrial plants. For industrial purposes water-tube boilers were, he contended, greatly superior as regarded efficiency to shell type boilers, such as the Lancashire. Shell type boilers had, however, certain outstanding advantages, such as low capital cost and indifference to the quality of the water supplied to them. They were, however, open to serious losses caused by faulty running. It seemed to him that there were opportunities for applying automatic combustion control to industrial plants using shell type boilers, and that there was no reason why by that means their efficiency should not be made as good as that of corresponding water-tube boilers.

Mr. W. G. Thomas thanked the authors for their commendatory remarks concerning the Bailey system of automatic control and dealt with certain features of that system which, he thought, had been faultily described or insufficiently stressed by the authors.

Mr. F. L. Cater gave some figures showing the savings which had been achieved by the adoption of automatic combustion control in some American power stations. The figures varied from 1 per cent. at the Hell Gate station to 11 per cent. at the Lowellville station. He pointed out, however, that the figures were not strictly comparable, as the conditions under which the stations were operating before automatic control was installed varied considerably from station to station. For example, the Lowellville station had previously been working under bad conditions and therefore showed a high saving when automatic control was adopted. It is understood that the system in use at the stations referred to by Mr. Cater is the Smoot.

Mr. C. Verity contended that there were many features of boiler operation, especially in very large units, which could not be taken care of by any system of automatic combustion control. He was assured by the advocates of control systems that another little controller here or a sub-controller there would meet this, that, or the next contingency or requirement, but the truth was that boiler operation was not an exact science. A boiler could not be run satisfactorily merely on calculations; it required long personal experience. The diagrams given by the authors were simplified and bore no real relationship to the complexities of the actual control systems which they represented. If automatic control were to become generally adopted it would, he felt certain, have to be developed on simpler lines than those now followed. It was, he thought, a mistake on the part of advocates of automatic combustion control to state, as the authors did, that its adoption permitted a reduction to be made in the size of the operating staff. With a reduced staff chaos would result in the event of a breakdown. Discussing the Hackney test results, which showed an efficiency of 84 per cent. when the automatic control system was in operation and an efficiency of only 78·1 per cent. when the automatic system was temporarily suppressed in favour of hand control, he asked the authors to state whether the station staff was given an opportunity of acquiring a thorough knowledge of the boilers before the hand control tests were run.

Mr. E. H. Smythe thought that as a piece of propaganda for automatic combustion control the paper would have served its purpose better if it had given more results than it did showing the savings effected by actual plants that had been installed. The paper, too, might have covered all the economic aspects of automatic control as applied, not only to new, but to existing boiler plants. He understood that in the case of a new boiler plant equipment for the complete automatic control of the combustion would cost from 2½ to 3 per cent. of the cost of the boilers. Those figures, however, related to large water-tube boilers. It would be interesting to have corresponding figures for simple Lancashire boilers with complete and also with partial automatic control.

Dr. A. Ivanoff discussed in detail the Kent method of correlating the load on the boiler with the operation of the dampers and other controls.

Mr. Brooks, like Mr. Thomas, defended the Bailey system against certain criticism of it made in the paper. He illustrated on the screen the Bailey method of controlling the feed water pressure in order to vary the supply to the boiler in accordance with the steam demand upon it.

Mr. J. E. O'Breen criticised the authors on certain points relating to their description of the Hagan system and charged them with having compared a modern Kent installation with the methods used in the Hagan system six years ago and now completely out of date. He deprecated the making of exaggerated statements concerning the savings which could be effected by the adoption of automatic combustion control. He could, he said, produce test figures showing savings of 10 to 15 per cent. and even in one case of 28 per cent., but these figures had been obtained from plants at which, as at Hackney, the hand control conditions left much to be desired. In well-operated plants an improvement of from 2 to 3 per cent. in the efficiency could be realised by the adoption of automatic control, and he felt certain that some such improvement and not one of as much as 7 per cent. would have been found at Hackney had the staff been used to the hand control of the boilers. Mr. O'Breen included in his remarks some brief particulars of an interesting automatic control installation of the Hagan type which is in use at the Laughlin and Jones Steel Works at Pittsburgh. This installation controls three boilers adapted to burn either blast-furnace gas or powdered fuel, and switches the boilers over from the one to the other according to the rapidly fluctuating volume of blast-furnace gas available. It would, he said, have been practically impossible to have operated the boilers with manual control without incurring poor efficiencies, large steam pressure variations, and great dangers of explosion. With the Hagan installation the fans were started, speeded up, and slowed down, the feeders and dampers opened or closed, and the air supply regulated correctly to suit each fuel, all the operative movements being made automatically and smoothly.

Mr. Barker supported Mr. Verity and called attention to the fact that the Dunston B, Blackburn Meadows, Clarence Dock, and Battersea stations were not being or had not been fitted with automatic combustion control. He thought it was desirable not to be too enthusiastic with regard to the merits of automatic control, and that it should be regarded as being still in the experimental stage.

Mr. Robinson, replying briefly to the discussion, commented upon the alleged complexity of automatic control equipments. He denied that such complexity existed or, if it did, that it amounted to anything approaching that found in, say, an automatic telephone exchange. As for mishaps, there was little that could go seriously wrong. Electrical contacts gave the principal trouble and any defect which arose from that cause was easily put right. Speaking as a user of automatic control, he did not, he said, put too much credence in the results of the Hackney test. He could not vouch that the plant was in the same condition during the hand control and the automatic control tests. He could, however, assert that the staff had had months of experience with the boilers under hand control conditions; that every effort was made during the hand control test to beat the automatic control figures, but that they could not be equalled by a considerable margin.

German High-speed Oil Engines for Railcars

THE Daimler-Benz Company, of Germany, originators and exponents of the pre-combustion chamber principle, have augmented their range of high-speed Diesel engines by the introduction of two new models, which have, in the first place, been designed for the propulsion of railcars. There is a very great future for railcars in Germany. In his New Year message for 1934, Herr Dorpmüller, the president of the German Railway Company, the largest enterprise of its kind in the world, has once more definitely stated his intention of reorganising the entire German train services, which are gradually to be superseded by fast railcar services. Trains of the old type are only to be run in future to cope with the mass traffic in the short-distance services to and from the large centres during the main business hours. For the long-distance services railcars are to be run at relatively close intervals, and already work has been taken up in all parts of the country to effect the necessary permanent way improvements and advance the distance signals to meet the requirements of average travelling speeds lying round about the 100 miles per hour border. The coming years, therefore, will bring a big demand for suitable Diesel engines, and the German industry is hard at work preparing to meet it.

Of the two new Daimler-Benz models, which comprise a six-cylinder and a twelve-cylinder unit of 150 and 330 B.H.P. respective outputs, the smaller is already operating in practical service in considerable numbers, while the larger has just passed the rigorous bench tests prescribed by the railway orders and in the presence of the railway engineers. The result of these bench tests has been so satisfactory that further engines have immediately been ordered without awaiting the practical service results of the trial engines in a railcar.

SIX-CYLINDER ENGINE.

The six-cylinder engine—Figs. 1 and 2—has a single cast iron cylinder block with inserted wet liners of chrome-nickel iron having a bore of 125 mm. (4·921in.). It is mounted on a deep cast iron crank case with a relatively flat sump pan attached. The cylinder head is divided, each half covering three cylinders. Looking forward from the fly-wheel end of the engine, the valves, two for each cylinder, are arranged hanging in one line slightly to the left of the centre line of the cylinders, while the pre-combustion chambers are arranged slantingly on the right side between each set of valves in the cylinder heads. The slanting position of the pre-combustion chambers, which direct the fuel spray axially into a shallow cavity on the piston head, has been found to effect a very notable improvement in regard to "sweetness" of running as compared with the perpendicular arrangement formerly favoured by the company.

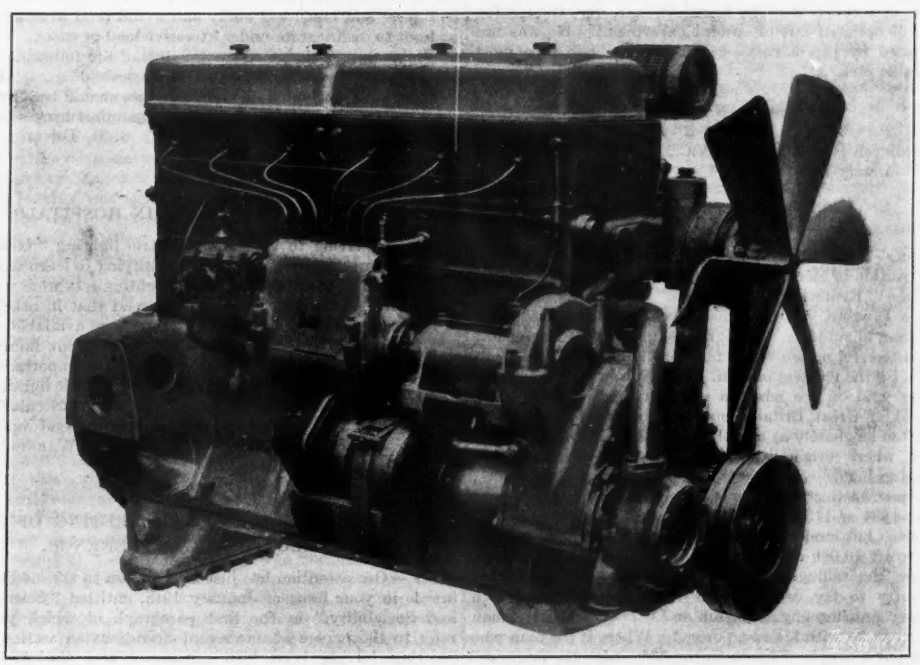


FIG. 1—SIX-CYLINDER 150 B.H.P. DAIMLER-BENZ RAILCAR ENGINE

The crank shaft runs in seven plain bronze-backed lead-zinc bearings, three large ones at the ends and in the centre and four narrower ones in between. These bearings have shown exceptional stamina in Daimler-Benz engines. Cases have been reported of bearings being in perfect condition after 155,000 miles. The crank shaft is supported in the transverse bulkheads of the crank case in bearings of the usual type with caps screwed on from below. The

centre bearing is held in a double wall. The bolts securing the caps of the second to the sixth bearing—that is, all but the end bearing—pass up through the transverse webs of the crank case, and their upper ends help to secure the cylinder block. The crank shaft is drilled for lightness and has the usual oil holes from the main bearing to the connecting-rod journals. The fly-wheel is flanged on. The forward end projects from the crank case and carries outside a vibration damper of the friction type. On the forward end, within the timing case extension of the crank case in front of the front bearing, a helical timing gear is fitted. It meshes with a composite gear on the cam shaft, and in order to prevent vibrations being transmitted the oil passes out in the same manner at the front bearing bracket and is conducted through pipes to the timing and auxiliary gears. The rockers of the exhaust valves have short extensions beyond the studs over the ends of short upright push rods, which normally do not come into contact with the rocker ends. The push rods stand on flat faces worked on a common cam shaft running the length of the cylinder block near the upper edge in the push rod compartment. This shaft can be turned by means of a special key from the forward or rear end of the engine to open the exhaust valves and release compression for starting.

The inlet and exhaust valves have the same head diameter of 53 mm. (2·086in.) and the same lift of 12 mm. (0·472in.). They are fitted in the normal manner with two concentric coil springs and have a seat angle of 45 deg. The intake manifold consists of five pieces, two of which, flanged to the cylinder heads, are so jointed as to form one normal manifold, from which, at the rear end, a knee pipe with a butterfly throttle and a long pipe lead forward alongside the engine. The pipe terminates in a large air cleaner and the arrangement appears to have been chosen in order to be able to provide a throttle for stopping the engine or facilitating starting the cold engine as also to dampen suction noise. The exhaust pipes are divided. Each section contains plugged holes opposite the valve ports, these being provided as a means for controlling the combustion in each cylinder.

A Bosch injection pump with integral governor and fuel supply pump is fitted on a bracket provided on the right side slightly forward of mid-engine. It is driven by an enclosed shaft on a bracket between it and the timing gear case. Bosch nozzles of the well-known needle valve type are employed. The injection system is set for a working pressure of 930 lb. per square inch. The nozzles are axially in line with the ante-chambers, and, therefore, similarly inclined. To facilitate cold starting, heating plugs are horizontally inserted in the pre-combustion chambers, which are cast integral with the cylinder head, and have large water passages around them. Screwed into the lower cylindrical end of the pre-combustion chambers, after their threads have been graphited, is a Daimler-Benz atomiser.

LUBRICATION.

The lubrication system, in part already described, is of the dry sump type, a separate external oil tank being required. A threefold lubricating pump, the three gear sets arranged one above the other, is situated in the deep sump recess just in front of the fly-wheel. The body is built up of several horizontal sections, and is flanged on the foot of the upright tube surrounding the pump-driving shaft coming down from the rear bearing of the cam shaft.

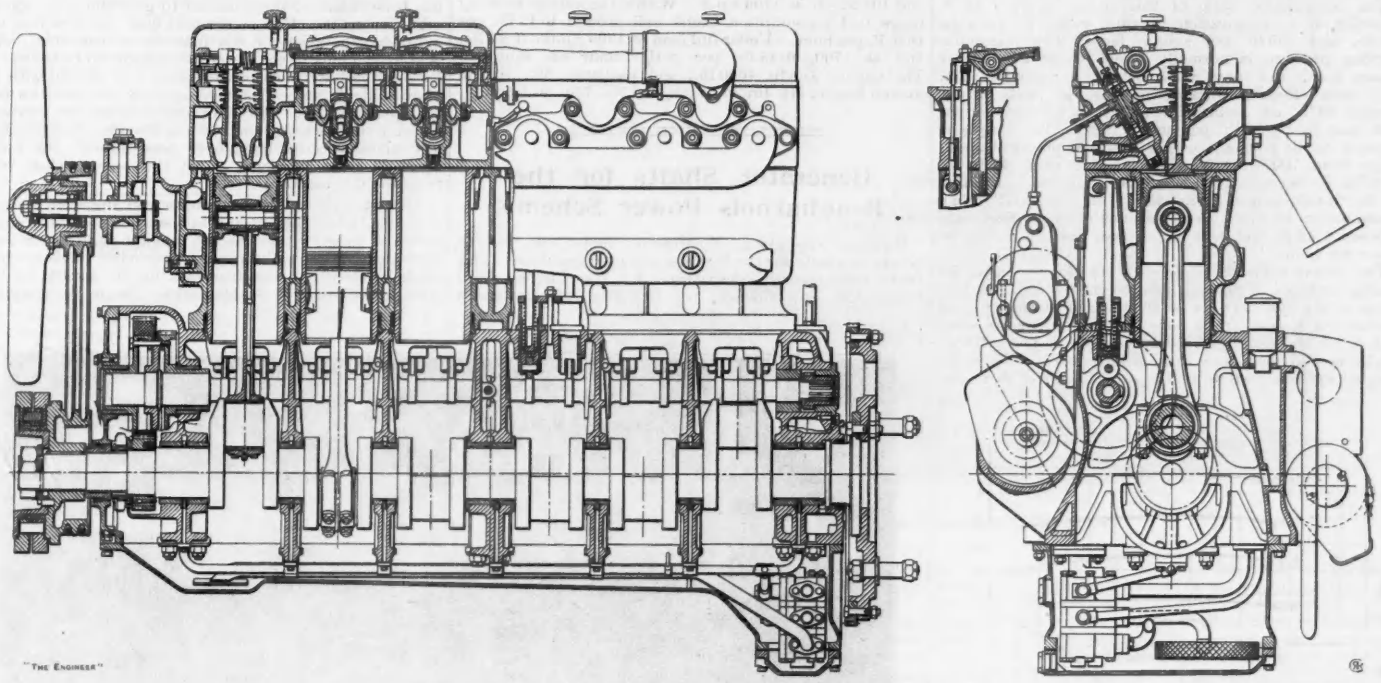


FIG. 2—SECTIONAL ELEVATION AND END VIEW OF SIX-CYLINDER ENGINE

tooth ring is made separate from the hub keyed on the crank shaft, clutch pieces and eight small coil springs being employed to establish a resilient connection between the two. The actual play is, of course, exceedingly small.

As has already been stated, the bore of the cylinders is 125 mm. (4·921in.). The stroke of the pistons is 170 mm. (6·693in.), so the swept volume amounts to 12,517 cubic centimetres, or 763·8 cubic inches.

The steel connecting-rods are of I section and weigh 13·1 lb. each complete. They measure 370 mm. (14·6in.) between centres and secured on their flanks are pipes conducting lubricating oil up from the big end to the eye and its bronze bushing. The gudgeon pins are full floating and are secured by end caps in the piston bosses. The pistons are of Elektron. Four compression and one oil scraper rings are fitted all above the gudgeon. The pistons are 176 mm. (6·9in.) long and weigh, exclusive of pins, 5 lb.

The cam shaft, as already indicated, is driven at the forward end. It is on the right side of the crank case and runs in four bushings. The composite gear is secured on a flange turned on the cam shaft, the rear end of which, behind the fourth bearing, is splined to carry the thimble hub of a worm gear. This drives a perpendicular lubricating pump shaft, which passes down to the sump inside a tubular casing. The cam shaft is drilled its entire length and has transverse bores at the bearings. The timing case extends over the right side of the crank case, where two gears are arranged above one another, the upper for driving the injection pump, the lower for driving a generator. The gear of the latter meshes with a gear fixed on the rear side of the cam shaft flange and is secured by the same screws as the composite gear, which meshes with the injection pump gear.

The right side of the cylinder block casting has covered openings giving access to the tappets and push rods. The cam followers are of the roller type, the rollers being fitted in the ends of piston-like bodies moving within flanged bushes or guides. The coil springs pressing the roller pistons down on the cams are held in place by forked holding plates. These are fitted horizontally on studs between the adjacent push rods on the crank case and the prongs of the forks embrace the two push rods forming simultaneously the abutment for the top of the spring, the lower end of which surrounds the seat of the push rod inside the piston member.

The cylinder heads have three exhaust ports, while the three inlet valves have a common intake passage with two ports all opening towards the left side, the two inlet ports being between and above the exhaust. The valve rockers are threaded on hollow shafts, one on each cylinder head, each supported in four bearings. The rockers are located by distance tubes and coil springs in the usual manner and move on bronze bushings. The push rod ends of the rockers are provided with the usual ball-ended studs, whose spherical ends rest in cups on the ends of the tubular push rods. The valve ends are plain, but a feature is the efficient lubrication that is provided. Pressure oil coming from the lubricating pump through passages in the cylinder block enters the rocker shaft of the rear cylinder head through the end bearing bracket and reaches the rocker bearings through holes. From the rocker bearings holes lead to the push rod and to the valve ends, where other holes conduct the oil to the contact faces. From the rear rocker shaft the oil passes *via* passages in the end bearing bracket and the cylinder head through an external pipe in a similar manner to the rear bracket of the rocker shaft on the forward head. Having lubricated the rockers there, the oil collecting in a shallow trough in the forward end of the oil pan is drawn through a strainer and pipe by the lowest gear set of the pump, and delivered to the set above, which, additionally, draws in the oil collecting in the rear recess. The two currents thus collected are driven together out to the oil tank. The top gear set draws fresh oil from the tank and delivers the main quantity through a short pipe with relief valve, set to open at 115 lb. per square inch, into a distribution pipe running along under the main bearing caps and flanged to them. It reaches the main bearings, the big end journals, and, as previously described, also the gudgeons. From the fly-wheel end bearing a passage in the rear crank case wall conducts the oil to the rear cam shaft bearing, whence it floods the hollow cam shaft, reaching its bearings through bores. Part of the oil is delivered by the uppermost gear pump up the tubular casing surrounding the pump shaft, and reaches the rocker bearings through passages provided in the cylinder block and rear cylinder head.

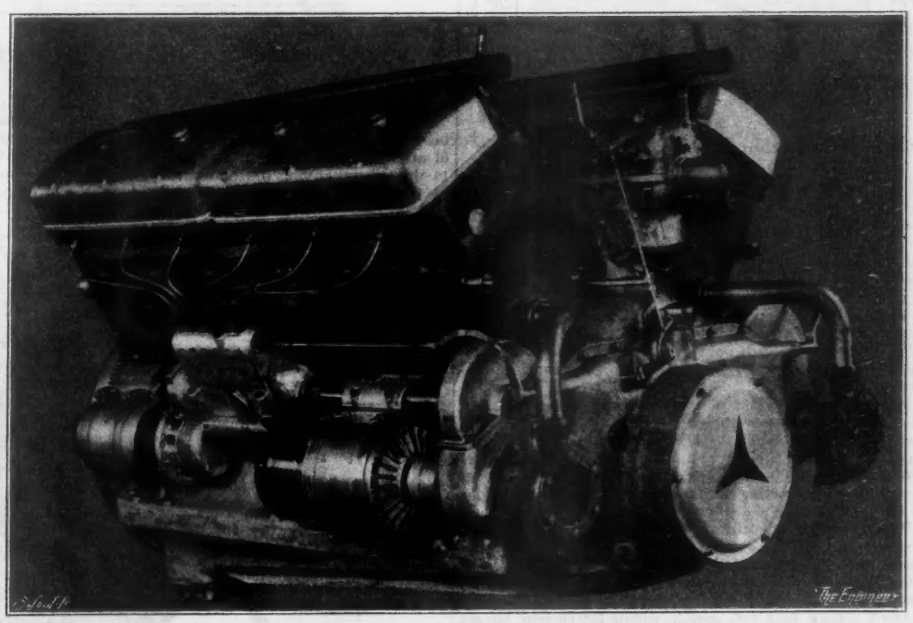


FIG. 3—TWELVE CYLINDER 330 B.H.P RAILCAR ENGINE

THE COOLING SYSTEM.

The water cooling system is normal, and comprises a vane-type impeller in a casing fitted on the timing gear cover, and driven off the same line as the generator. The water enters the block at the front end. A by-pass passage cast in on the left side of the cylinder block

conducts part of the fresh water current straight to the rear cylinders. For engines which can be placed immediately behind the radiator a fan fitting is obtainable. In the latest form this consists of a dual pulley for V-belts fitted on the crank shaft between the vibration damper and the crank case.

The engine has a temporary hour peak output of 150 B.H.P. at 1700 r.p.m., while the constant peak output maintainable for any length of time is 135 B.H.P. at the same speed. At 1500 r.p.m. the respective performances are 136 and 123 B.H.P.; at 1000 r.p.m., 103 and 92 B.H.P., and at 700 r.p.m., 63 and 56 B.H.P. The ignition order of the cylinders is 1, 5, 3, 6, 2, and 4, number 1 being the cylinder nearest the fan.

The compression ratio of this engine is 17·5 to 1, resulting in a compression pressure rising to between 425 lb. and 455 lb. per square inch. The maximum working pressure is normally round about 570 lb. per square inch, and may reach 640 lb. per square inch. The mean effective working pressure at peak output reaches 99 lb. per square inch, and appears at normal high load to be 96 lb. per square inch. The torque is reported to be constant over the whole practical speed range from 700 to 1700 r.p.m., rising from 455ft.-lb. to 477ft.-lb. between 1200 and 1400 r.p.m., and subsiding to the initial torque at maximum engine speed. Fuel consumption is also very reasonable as it fluctuates between 0·42 lb. and 0·44 lb., at most 0·45 lb. per horse-power per hour.

The twelve-cylinder engine—Fig. 3—incorporates the leading features of the six just described, but has two banks of six cylinders set at an angle of 60 deg. to one another on a deep crank case of silumin gamma alloy with a flat and deeply ribbed bottom pan. The cylinder blocks are divided into four groups, each with three inserted cylinder barrels of the same material as in the

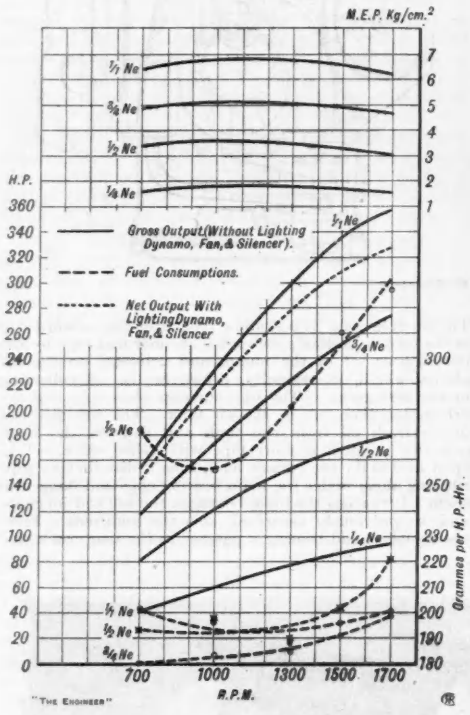


FIG. 4—TEST RESULTS OF 12-CYLINDER ENGINE

six-cylinder engine. The dry sump lubrication system is slightly simpler. Only a dual pump is employed. It is driven off the rear end of the right cam shaft, and it pressure-lubricates the main and big end bearings, the valve gear, and the governor. The latter is a separate unit situated in the V-saddle at the forward end of the engine, and driven by a vertical shaft off the crank shaft. The cam shafts are on the outside and are driven in the same manner at the forward end, as previously described.

The cylinders have a bore of 138 mm. (5·4in.), and the pistons a stroke of 170 mm. (6·7in.), so the swept volume amounts to 1861 cubic inches.

Each bank of cylinders has its own Bosch injection and water circulation pumps situated and driven in the identical manner as on the six-cylinder unit. The water pump shaft of the right cylinder bank, extending rearwards, drives a 1200-watt, 24-volt generator. Twelve horse-power electric starting motors are fitted on both sides of the engine.

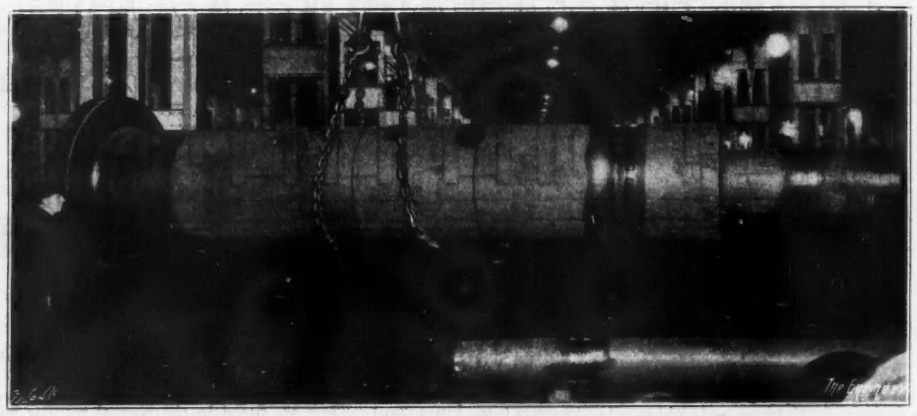
The governor operates a transverse shaft across the forward end of the engine enclosed within the timing case cover. The ends projecting at the sides carry levers, which are linked with the two injection pumps, so that both these are regulated by the one governor. This controls idling and top speed, which latter can be set by a suitable mechanical transmission system to maintain any speed between 1000 and 1700 revolutions per minute. The governor shaft projects in front, and is shown in Fig. 3 covered by a cap. On this stump a fan can be fitted if required. To facilitate starting the same decompression means as on the six-cylinder engine are provided. In addition, there are the same heating plugs.

The crank shaft of this engine, also, is fitted at the forward end with a frictional vibration damper. This is, however, encased. Since on railcars the engines can rarely be directly under the driver's observation, remote control is provided. Coupled in the shaft drive of one of the injection pumps is a small dynamo, the performance of which is electrically communicated to two or three dials indicating the number of crank shaft revolutions. Electric thermometers and mechanical-electrical oil-pressure gauges are also provided. Some results of tests are shown diagrammatically by Fig. 4.

Working without exhaust silencer and without fan, and with the generator running idle, the engine reaches a maximum output of 358 B.H.P. at 1700 r.p.m., while with these fittings in place, 326 B.H.P. is delivered. At 1500 r.p.m. the respective outputs are 336 and 310 B.H.P.; at 1300 r.p.m., 300 and 280 B.H.P.; at 1000 r.p.m., 232 and 220 B.H.P., and at 700 r.p.m., 154 and 146 B.H.P. The highest mean effective working pressure occurs between 1000 and 1300 r.p.m., and is at full load 96·7 lb. per square inch. It drops to 93·8 lb. and 89·6 lb. per square inch at 1500 and 1700 r.p.m. respectively. Torque is 1039ft.-lb. at 700 r.p.m. It rises to 1157ft.-lb. at 900 r.p.m. to 1171ft.-lb. at 1100 r.p.m., and gradually decreases to 1157ft.-lb. at 1300 r.p.m.; 1114ft.-lb. at 1500 r.p.m., and 1042ft.-lb. at 1700 r.p.m. Within the normal working range fuel consumption keeps well around 0·42 lb. per B.H.P. per hour. Under full load at 1500 r.p.m., 0·44 lb., and at 1700, 0·48 lb. per B.H.P.-hour are required. The engine weighs 4000 lb., and measures 5ft. 7in. in overall length, 3ft. 4in. in width, and 3ft. 7¼in. in height.

Generator Shafts for the Beauharnois Power Scheme.

THE accompanying illustration shows one of the generator shafts for the Beauharnois power scheme. This shaft was recently despatched by the English Steel Corporation, of Sheffield, to the site. It transmits

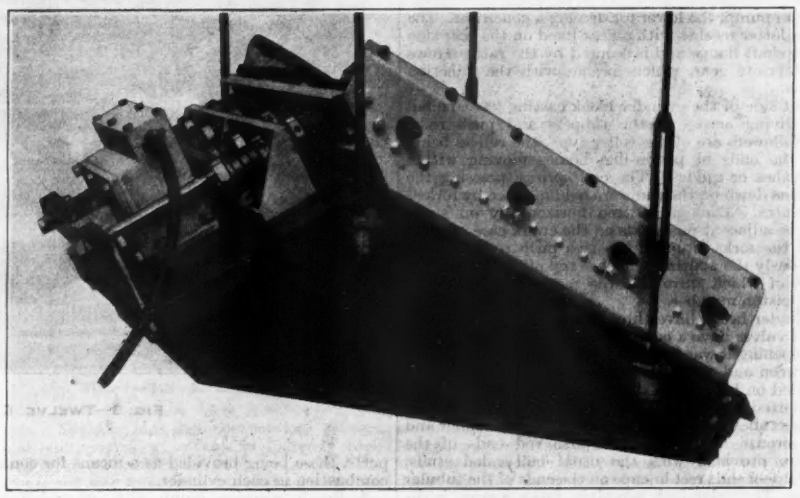


GENERATOR SHAFT FOR BEAUHARNOIS

53,000 H.P. at 75 r.p.m., weighs approximately 36 tons, and has a diameter of 37in. These shafts, which are claimed to be the largest in the world, are made in pairs necessitating the casting of an ingot weighing 119 tons. As soon as the ingot is cool enough to be stripped from the mould, it is taken to the forge and heated for two to three days. It is then forged under one of the most powerful hydraulic presses in the country, several re-heats being necessary during the forging process.

A New Electro-magnetic Vibrating Screen.

THE demand for a vibratory screen that can be connected to any A.C. supply and requires a minimum amount of attention has been met by the Sherwen Screen, shown in the accompanying illustration. It has been developed at the Fraser and Chalmers Engineering Works of the



ELECTRO-MAGNETIC VIBRATING SCREEN

General Electric Company, Erith, Kent, and exhaustive tests with many materials are said to have given satisfactory results in all respects. The machine works without a motor generator, and the contact gear used on the original type of screen is eliminated. The vibrations are obtained by the use of a Westinghouse half-wave metal rectifier connected in series with the vibrator coils. The operation begins with the rectified half-wave from the rectifier passing to the vibrator coils, and drawing forward the armature which is connected to the screen frame. During the other half-wave of the A.C. cycle the current is prevented from passing to the coils, thus enabling the springs supporting the armature and live screen frame to accomplish the return stroke. A 50-cycle A.C. supply transmits to the live screen frame a vibration of 3000 cycles per minute.

Long experience is said to have shown that the Westinghouse metal rectifier is absolutely free from trouble, and it has a great advantage over the motor generator under the dusty conditions met with in many industries. As in the case of the original Sherwen screen, the vibrating unit is fixed at the back of the screen frame and advantage has been taken of this position to give the most intense vibration to the cloth at the feed end. At this feed end a quick separation of the material is beneficial, as it enables the bulk of the undersize material to be taken out, leaving the lower part of the screen free to deal with the more difficult process of dealing with the particles near to aperture size. The gradual decrease in vibration towards the discharge end also has the effect of restraining any material small enough to pass through the screen aperture from bouncing down the screen when freed from the fine material.

The intensity of vibration and screen angle can easily be controlled while the screen is in operation, and little supervision is necessary, for as the moving parts are entirely spring supported no lubrication is needed. The screen is made in standard sizes from 3ft. by 5ft. to 4ft. by 8ft., with either single or double decks. The power consumption is said to be extremely low, and as the screen is suspended and insulated from the supporting structure by rubber buffers, loss of vibration is minimised

Water Softening.

WE have received from Imperial Chemical Industries, Ltd., a copy of a handbook entitled "The Control of Water Softening and Boiler Feed Water Conditioning." This booklet is a practical sequel to two publications previously issued by I.C.I., in which the applications of the lime-soda process to the respective problems of industrial water softening and boiler feed water conditioning were fully discussed in their theoretical aspects. It has been designed to show how users of the process for these purposes may be enabled to maintain a close control of the composition of the water used. Such a control is of the greatest importance, since the efficiency of many industrial operations is easily impaired by variations in the composition of the water supplied. All the tests described are essentially simple, rapid and reliable, and have been made even more so by the provision of convenient formulæ for calculation purposes. Detailed practical instructions are given in the first part of the booklet for the rapid determination of the total alkalinity of raw water, as well as of its hardness in respect of both lime and magnesia

salts, the distribution of which, as temporary and permanent hardness, is of first importance in considerations of boiler feed. Simple general formulæ, based on the results of these analyses, are given for the calculation of the approximate quantities of lime and soda ash required for softening, and the necessary modification of the treatment for deep well waters, and others which may contain free bicarbonate of soda, is dealt with in a useful note. In a description of the analysis of the softened water prominence is given to the detection of caustic alkalinity by the barium chloride-phenolphthalein method. This enables the caustic alkalinity to be kept down as far as is consistent with the efficient removal of magnesia, and thereby minimises the chances of caustic embrittlement in the boilers. The hardness determinations described most fully in the booklet are due to Blachner and are recommended by the authors as rapid and accurate methods. The still widely used, but less accurate, method of Wanklyn, depending upon the formation of a permanent lather, is given as an alternative method of determining total hardness, and its limitations considered. The second part of the booklet deals with the practical aspects of boiler feed water conditioning, and analyses for blow-down control.

Locomotive for China.

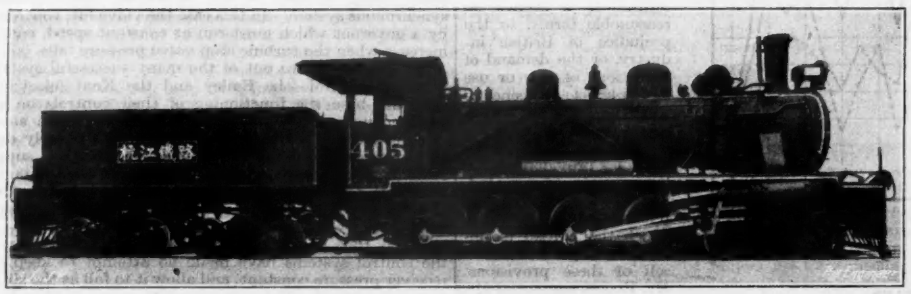
THE locomotive illustrated is one of six just delivered by the Hunslet Engine Company, Ltd., Leeds, for the Hangchow-Kiangshan Railway. The general particulars are set out below :—

Gauge	4ft. 8½in.
Cylinders	410 mm. dia. by 550 mm. stroke
Eight wheels coupled	1120 mm. on tread
Four wheels bogie	720 mm. on tread
Coupled wheel base	3900 mm.
Total engine wheel base	6712 mm.
Heating surface	871 square feet
Superheater elements	376 square feet
Total heating surface	1247 square feet
Grate area	19·4 square feet

Owing to the lightness of the rail an axle weight of 8·2 metric tons with an even distribution of weight on the coupled wheels was a hard-and-fast condition.

The following fittings are included :—Multiple valve regulators, by the Superheater Company, Ltd., London ; "Nicolai" piston valves, made by the Hunslet Engine Company, Ltd., under licence from the patentees, Messrs. Nicolai Kolbenschieber G.m.b.H., of Elbing ; brake equipment and pneumatic sanding gear and steam heating equipment, by the Westinghouse Brake and Saxby Signal Company, Ltd. ; axle-boxes made by the British Isothermos Company, Ltd., on the tenders ; and electric lighting equipment for engine and train, J. Stone and Co., Ltd., of Deptford.

The coupled wheel axle-boxes are fitted with the "Ajax" patent automatic hard grease lubricators and the bogie axle-boxes with "Ajax" automatic soft grease lubricators. The coupling and connecting-rods and valve motion are all lubricated by "Tecalemit" grease nipples and the cross-heads and slide bars by means of "Tecalemit" spring feed lubricators. All this lubricating equipment was designed and supplied by Messrs. Whitelegg and Rogers, of London, who have also supplied one of their "Ajax" air-operated grease block compressing machines for the making of axle-box grease blocks, and also an "Ajax" hand-operated compressor for making grease sticks for use with the grease guns.



LOCOMOTIVE FOR HANGCHOW-KIANGSHAN RAILWAY

A Grab Dredger for Nassau.

To complete the trials of a dredger on the far side of the Atlantic in less than six months from the date of receiving the order may or may not be a record for a British firm, but Priestman Bros., Ltd., and their sub-contractors are to be congratulated on having achieved this remarkable result in connection with the grab hopper dredger "Lucayan."

On June 3rd, 1933, the Crown Agents for the Colonies, on behalf of the Government of the Bahamas, placed an order with Priestman Bros., Ltd., of Hull, for a 60-ton grab hopper dredger, and the vessel was launched on September 26th, the speed trials passing off satisfactorily on September 28th, 1933. She is shown at work at Nassau in the accompanying engraving.

At the conclusion of the trials the vessel sailed round to Liverpool under her own power, and though she encountered heavy gales during the voyage through the Irish Sea, she completed the journey without incident on October 14th and was lifted aboard the s.s. "Atlantian" in the Liverpool Docks. The lifting of the hull was carried out very expeditiously by the Mersey Docks and Harbour Board in conjunction with the officials of the Leyland Line, the floating crane being alongside the "Atlantian" for a period of about half-an-hour only.

Later in the day the "Atlantian" sailed from the Mersey and, after calling at Bermuda, arrived at Nassau on October 28th. The "Lucayan" was lifted from the deck of the "Atlantian" and dropped into the harbour by the steamer's own gear, the erection of the grab dredging crane on the hull being commenced immediately.

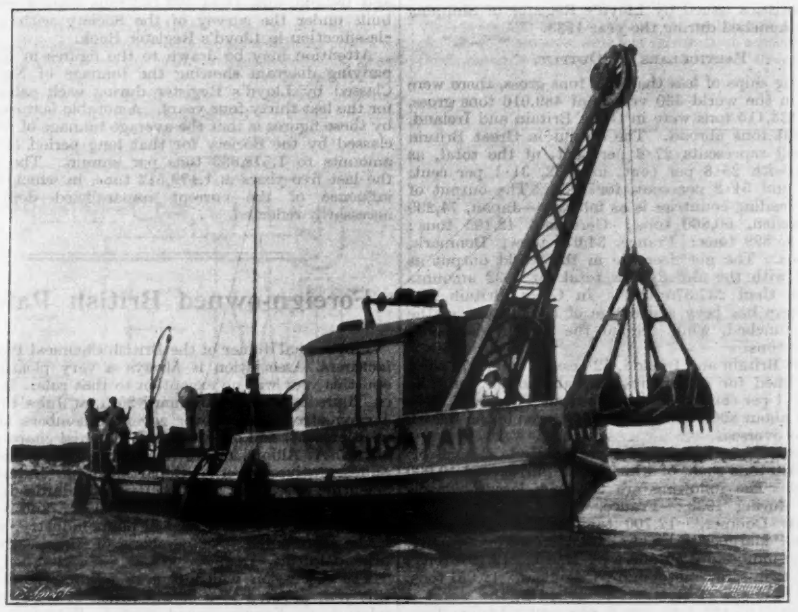
To save time, the grabbing machinery had not been fitted aboard the hull previously, but the erection was carried out with such despatch that the dredger had been completed and the dredging trials satisfactorily carried through by November 21st, and the mechanic who went to carry out the work in the Colony on behalf of Priestman Bros., Ltd., was back in England before Christmas.

The leading dimensions of the hull are 65ft. by 21ft. by 7ft., the mean loaded draught being 5ft. 6in., and, though small, this dredger has interesting characteristics, in that both the engines for the dredging crane and for propulsion are of the compression-ignition type. A speed of 6¼ knots was specified, but the 60–80 H.P. four-cylinder Gleniffer oil engine actually propelled the vessel at 6¾ knots on the trials. The vessel is divided into water-tight compartments by four bulkheads, and the hopper, which is fitted with bottom opening doors operated by hand gear, has a carrying capacity of 60 tons of spoil.

The dredging crane is of Priestman's Universal type and is driven by a four-cylinder oil engine developing 65 B.H.P. at 1000 r.p.m. This machine is used to operate a heavy plate grab of 1-yard capacity for dredging coral sand in the vicinity of the harbour at Nassau.

It was understood that prior to the delivery of the dredger the officials in the Colony had estimated that if three loads per day were dredged and taken to sea this would be considered very satisfactory, but actually the dredger has on many occasions made six trips per day.

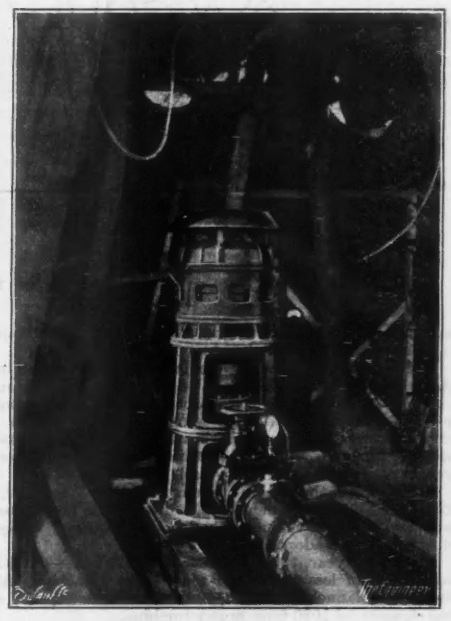
This contract was carried through under the supervision of the consulting engineers to the Crown Agents, Messrs. Coode, Wilson, Mitchell and Vaughan-Lee.



THE GRAB HOPPER DREDGER "LUCAYAN"

Emergency Pumping Plant.

SHORTAGE of water at the paper mill of J. A. Weir, Ltd., of Kilbagie, near Alloa, caused by the drought, demanded emergency measures. On December 29th last the Harland Engineering Company, Ltd., of Alloa, was commissioned to supply, erect and set to work a bore-hole pumping plant, to deliver 1,000,000 gallons of water a day from a disused colliery shaft, half a mile from the mill, on condition that the plant should be running by 10 p.m. on January 7th. The job was ready by 3 p.m. on the specified date, waiting for power supply, and was started up at four o'clock, though the New Year holidays intervened, representing a works shut-down of five days—half the time allowed. The pump delivers 700 g.p.m. at 290ft. head, and is located 240ft. below the surface. It is driven by an 85 H.P. vertical squirrel-cage motor, three-phase, 50 cycles, 440 volts, at 1470 r.p.m. Duplicate filters are installed for providing clean, grit-free water for lubricating the bearings carrying the long vertical driving shaft which runs inside the rising main pipe. As a protection against failure of these bearings, an electrical and hydralic interlock is fitted, arranged to shut down the set in the event of a stoppage of the lubrication water. There are thirty-three lengths of rising main pipe, internal tube and driving shaft between the motor and the pump. The bulk of the plant was despatched from the works by January 2nd, and transported by road, and then across more than a quarter of a mile of soft fields and rough ground to the site. Motor lorries, a tractor and horses and carts were employed on this work. Thirty-ton sheer-legs had to be erected before installation could begin, and then work was carried on continuously in three shifts. Artificial light was improvised by acetylene and paraffin flares, and automobile headlamps driven by car batteries ; even stable lamps were requisitioned. The set was started up at 4 p.m. on January 7th, and ran without a stop until the night of the 13th. It is now running continuously night and day. D. Selby Biggs and Co., of Glasgow, were the consulting engineers. The illustration shows the motor erected above the shaft under a temporary shelter.



MOTOR FOR EMERGENCY PUMPING PLANT

ALTHOUGH the British Industries Fair does not open until February 19th, inquiries for hundreds of British products have already been received from buyers in thirty-three countries in response to advance information sent abroad by the Birmingham Fair Management Committee. Brewery equipment for America, military articles for the Balkans, aircraft materials for Turkey, non-ferrous metals for France, modern office equipment for Siam, power plant for Australia, refrigerators for Iraq, and agricultural and coalmining machinery for the Argentine, are among a long list of goods for which prices and other information are asked. The demand for space continues and up to date a total area of 796,817 square feet has been booked by exhibitors.

Lloyd's Register of Shipping.

ANNUAL SUMMARY.

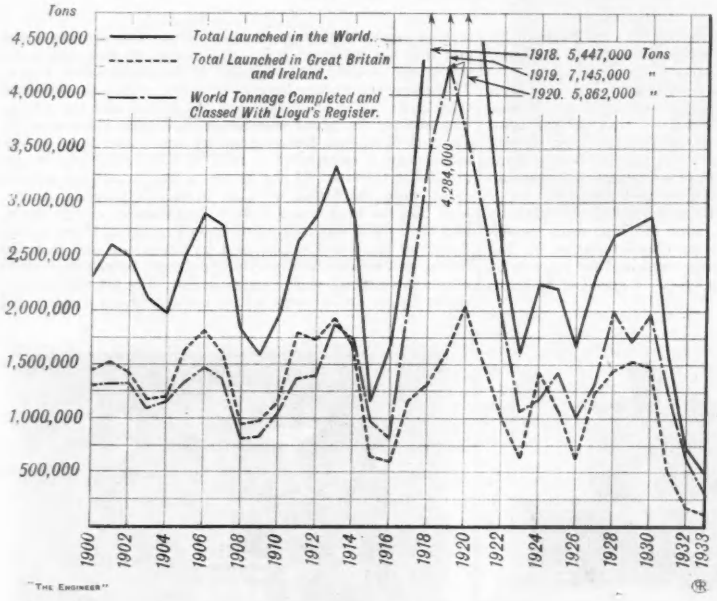
THE continued falling off in the output of the shipbuilding industry throughout the world is vividly demonstrated by the statistics issued by Lloyd's Register of Shipping of vessels launched during the year 1933.

PARTICULARS OF OUTPUT.

Excluding ships of less than 100 tons gross, there were launched in the world 330 vessels of 489,016 tons gross, of which 133,115 tons were in Great Britain and Ireland, and 355,901 tons abroad. The output in Great Britain and Ireland represents 27·2 per cent. of the total, as compared with 25·8 per cent. in 1932, 31·1 per cent. for 1931, and 51·2 per cent. for 1930. The output of the other leading countries is as follows:—Japan, 74,290 tons; Sweden, 60,860 tons; Germany, 42,195 tons; Holland, 35,899 tons; France, 34,073 tons; Denmark, 34,016 tons. The net decrease in the world output as compared with the already low total for 1932 amounts to no less than 237,575 tons. In Great Britain and Ireland there has been a decrease of 54,679 tons in the tonnage launched, while abroad the decrease amounts to 182,896 tons.

In Great Britain and Ireland, 12 vessels, of 12,077 tons, were launched for owners residing abroad, or for sale, equal to 9·1 per cent. of the total output. Seven of these vessels, of about 8000 tons, will be registered in the British Dominions overseas.

The world launches for the year include 29 vessels of over 6000 tons each, of which only four exceed 10,000 tons each. The following are the four largest vessels launched during 1933:—France, twin-screw motorship "Président Doumer," 12,700 tons; Italy, twin-screw motorship "Marguerite Finaly," 12,426 tons; Germany, twin-screw motorship "Robert F. Hand," 12,197 tons; Germany, twin-screw motorship "Cordillera," 12,051 tons. The total tonnage of steamers launched in the world is 141,738 tons, 83,481 tons (58·9 per cent.) having been launched in Great Britain and Ireland, and 58,257 tons (41·1 per cent.) in countries abroad.



RECORD OF SHIPBUILDING IN 34 YEARS

During the year, there were launched five vessels of about 19,000 tons, which are to be fitted with steam turbines—in four cases in association with reduction gearing—and nine vessels of about 11,500 tons with a combination of steam reciprocating engines and low-pressure turbines. In Great Britain and Ireland there were launched three turbine vessels of 5190 tons.

Included in the steam tonnage is the "Arcwear," 4200 tons, built at Sunderland, which is the first vessel launched in which the new Isherwood "Arcform" design of hull has been adopted.

During the year, 12 oil tankers, of 82,675 tons—excluding vessels of less than 1000 tons—were launched. All these were launched abroad, and with the exception of one steamer, of 1080 tons, are motorships.

Of the steam tonnage launched in the world—141,738 tons—about 21,000 tons refer to steamers fitted to burn oil fuel under the boilers.

PROGRESS OF SHIPBUILDING DURING THE YEAR.

Lloyd's Register Quarterly Returns show that at the opening of the year 1933 the tonnage being built throughout the world was 765,720 tons. Since then there has been a slight decrease, the figures for the end of December being 757,277 tons, thus showing a reduction of 8443 tons as compared with December, 1932. In Great Britain and Ireland there has been an increase of 106,044 tons, the decrease in countries abroad being 114,487 tons.

At the beginning of 1934, only two countries had more than 100,000 tons of shipping under construction, viz.: Great Britain and Ireland, 331,541 tons, and Japan, 106,760 tons. Next in order were: France, 90,656 tons; Sweden, 64,640 tons; Holland, 40,540 tons, and Spain, 35,724 tons.

In view of the present figures of tonnage under construction, and taking into account the fact that the amount of tonnage laid down during 1933, as shown in Lloyd's Register Quarterly Returns, has exceeded by 28,000 tons the tonnage launched during the year, the position of the shipbuilding industry throughout the world shows some signs of slight improvement, though this is principally due to the increased activity in Great Britain and Ireland.

VESSELS CLASSED BY LLOYD'S REGISTER.

Of the merchant vessels launched during 1933, 134 of 293,991 tons (90 vessels of 98,829 tons in Great Britain and Ireland, and 44 of 195,162 tons abroad) were being built under the survey of the Society with a view to classification in Lloyd's Register Book.

Attention may be drawn to the figures in the accompanying diagram showing the tonnage of New Vessels Classed by Lloyd's Register during each calendar year for the last thirty-four years. A notable feature disclosed by these figures is that the average tonnage of new vessels classed by the Society for that long period (1900–1933) amounts to 1,578,633 tons per annum. The mean for the last five years is 1,179,512 tons, in which figure the influence of the current unparalleled depression is necessarily reflected.

Foreign-owned British Patents.

THE annual dinner of the British Chemical Plant Manufacturers' Association is always a very pleasant event, and this year was no exception to that rule. It was held on Thursday evening, January 25th, at Jules Restaurant, Jermyn-street, when over seventy members and guests were present, and dined under the genial chairmanship of Mr. E. A. Alliott, of Nottingham. The guests included representatives of the Department of Industrial and Scientific Research, the British Standards Institution, the Institution of Mechanical Engineers, and other associations allied to the chemical plant industry, which was itself represented by members of practically all the principal firms.

The discussion which usually follows the dinner was this year devoted to a consideration of "Patent Law in relation to Foreign-owned British Patents," and was opened by Mr. C. Hollins, of Imperial Chemical Industries, Ltd., who was followed by Mr. F. Heron Rogers. In his introduction Mr. Hollins pointed out that under Sec. 27 of the Patent Act, as it now stands, patents were not granted to encourage invention alone, but in order to secure their working in the United Kingdom without undue delay. He proceeded to analyse the present position, and went on to deal with many of the causes of abuse of monopoly by way of non-working, such as the refusal of a licence on reasonable terms, to the prejudice of British industry, or the demand of conditions of sale or use of the article or licence to work the process which might unfairly prejudice our industry. The remedies provided by the law were also enumerated, and Mr. Hollins then referred to the way in which the British manufacturer might avail himself of these provisions. Mr. Rogers supported Mr. Hollins, and dealt with the general position, which is a matter of some concern to British manufacturers of chemical plant. In the course of the discussion, Mr. J. Arthur Reavell spoke of some cases in which ridiculous royalty terms had been offered for licences to work foreign-owned British patents, and he outlined the manner in which certain foreign Governments are seeking to get over British import duties. His view was also strongly supported by Mr. K. Fraser, who complained that in most cases only very inadequate information as to the kind of plant to be imported was available, and in some instances royalties of 100 per cent. had been demanded. The President of the Institution of Mechanical Engineers, Mr. A. E. L. Chorlton, complimented the speakers on the very clear way in which they had presented their case. Such practical and scientific information was, he said, rarely placed at the disposal of Members of Parliament. In his reply, Mr. Hollins said that there would be eventually another Patent Amendments Act, and that an endeavour should then be made to correct the bias which it could not be denied did exist in favour of the foreigner under the Sec. 27 of the present Patent Act, which dealt with compulsory licences. In thanking the speakers, Mr. J. Davidson Pratt, the Secretary of the British Chemical Plant Manufacturers' Association, recalled the amendments to the 1932 Act secured by the efforts of Mr. Hollins and Sir Christopher Clayton, and he suggested that similar collective action should be taken when the next opportunity was presented.

WE are informed by the Secretary of State that he proposes to make, under Section 79 of the Factory and Workshop Act, 1901, an amendment in the Horizontal Milling Machines Regulations, 1928, which will provide that nothing in Regulation 3 (dealing with the fencing of cutters) shall apply to any milling cutter used for (*a*) making tools, jigs, or gauges for use in the factory, or (*b*) other accurate operations where the position of the work relative to the cutter during the cutting process is determined by the operator, and is not merely governed by a previous setting up of the machine.

Automatic Combustion Control for Boilers.*

By J. L. HODGSON, B.Sc., AND L. L. ROBINSON.

THE technique of automatic combustion control has been built up laboriously over a period of nearly 250 years. The first smoke-preventing contrivance—and attempts at smoke prevention were the beginning of automatic combustion control—was invented by a Frenchman named Delasme, and was exhibited at the Fair of St. Germain in 1685. Then follow the names of James Watt, who originated the coking stoker (1775); Thompson, who invented the fire-brick arch (1796); John and James Robertson, of Glasgow, who improved on Watt's invention (1800); Hawkings and Dowson, who invented the underfeed coking stoker (1819) and the "peristaltic" stoker with moving fire-bars (1822); John Stanley, who invented the sprinkling stoker (1822); John Bodmer, who invented the travelling grate stoker (1834) and a stoker which broke up clinker (1844); John Juckes, who modified Bodmer's invention into the chain grate stoker (1841); Robert Hall, who first applied water cooling to mechanical stokers (1845), and so on.

Of the early pioneers both Stanley and Brunton used a simple form of automatic damper control operated by the steam pressure. Maintenance of performance was in the early days considered of far more importance than the maintenance of efficiency. In fact, boiler efficiency, as we know it to-day, is almost a post-war development, as the following approximate table of maximum boiler efficiencies, steam pressures, and outputs will show:—

Year.	Maximum boiler efficiency, per cent.	Steam pressure, lb. per sq. in.	Maximum output per boiler, lb. per hour.
1907	70	100–225	50,000
1917	75	150–250	100,000
1925	84	250–650	300,000
1930	87	400–1400	400,000
1931	89	600–1800	500,000

The modern systems of automatic combustion control which have grown up in America, on the Continent, and in this country around the increasingly large water-tube boiler units using automatic stokers and forced draught, pulverised coal, oil, or gaseous fuels, all base the initial point of their control on the steam demand, as did the early control systems above referred to. Obviously any system of control must increase the rate of combustion until the demand is met.

If the steam pressure in the receiver into which a number of boilers feed is maintained, it is obvious that the steam supply must be equal to the demand. At first sight one would have thought that this simple fact would have been seized upon by the designers of automatic control apparatus and used as the starting point of their control, especially as reasonably constant receiver pressure ensures the maximum output of turbines which have to run at a constant speed as part of an electrically interconnected synchronous system. In this case the valve lift, controlled by a governor which must run at constant speed, cannot increase when the turbine stop valve pressure falls.

Actually only two out of the many successful systems of boiler control—the Bailey and the Kent (electrical) systems—base the functioning of their controls on the maintenance of a constant pressure at the main steam receiver feeding the turbine or plant. In the early days of boiler control large interconnected electrical supply systems were not thought of, and the obvious thing to do was to correlate outlet damper position (corresponding roughly to combustion rate) with fall of receiver pressure corresponding to load.

It has thus come about that the designers of most of the control systems have made no attempt to keep the receiver pressure constant, and allow it to fall as the steam flow is increased. This minimises "hunting" difficulties, because for each reduced receiver pressure there is a definite and increased load. Also, as there may be a loss of as much as 30 lb. per square inch between the boiler stop valve and the receiver at full load due to the resistance of the superheater, &c., the fall in the receiver pressure can without difficulty be measured with sufficient accuracy to be a reasonable indication of the load.

Usually about 5 lb. or 10 lb. per square inch fall of receiver pressure is allowed at full flow, and there is no difficulty in constructing devices capable of detecting and responding to one-hundredth part of this change. It may be stated here that the steam flow varies approximately as the square root of the change, provided that boiler pressure is kept constant by increasing the combustion rate. Throughout the paper the term "fall of receiver pressure" is used to denote a change of receiver pressure that is proportional to the square root of the load on the group of boilers discharging into the receiver, and which can therefore be used as a measure of the steam flow.

SUMMARY.†

(1) The physical quantities on which combustion control is based are boiler pressure, fall of receiver pressure, rate of change of receiver pressure, induced draught and forced draught damper positions, induced draught and forced draught fan speeds, furnace pressure, steam flow, steam temperature, air flow, CO_2 and CO measurements, stoker or fuel feeder speeds, primary air speed, and rate of water feed.

(2) Boiler and receiver pressures are measured by spiral Bourdon tubes, by Bourdon tubes arranged in parallel, by Sylphon bellows, by weight or spring-loaded diaphragms, by mercury columns, by diaphragms or mercury columns balanced against compressed air, and by rotary piston pressure gauges.

Draught and differential pressures are measured by oil-sealed bells suspended by springs or from a balance arm;

* The Institution of Mechanical Engineers.

† This portion summarises the contents of the succeeding parts of the paper. The concluding sections contain descriptions of thirteen of the more important control systems. Of these we reprint that pertaining only to the Kent electrical and hydraulic systems.—ED. THE E.

steam and water flow rates by means of orifices and differential pressure meters; steam temperature by means of thermo-couples (these, if welded to the thin projecting end of the thermometer pocket, are reliable to within ±5 deg.); stoker or feeder speeds by means of centrifugal weight, fan, or electrical tachometers.

Air flows are measured by the drop of pressure across orifices, constrictions, or boiler passes; CO_2 and CO by density or conductivity measurements or by continuous chemical analysis.

(3) The transmission of the control impulses is by electric currents of varying magnitude, voltage, or time duration; by Selsyn motors; and by oil, water, or air flows or pressures. "Loading" lines are used on several systems.

(4) The operation of the controls is by oil, water, or air-operated pistons; by motor-driven shafts thrown into gear by mechanical or electrical clutches; by variable-speed electric motors; by motors intermittently started, stopped, and reversed; by unidirectional motors operating through a differential gear and started in sequence after a measured time interval has elapsed; and by constant-speed motors driving through variable-speed gears or hydraulic couplings.

(5) The speeds of fans and stoker drives are regulated by shunt rheostats, or by varying the voltage when D.C. motors are used; and by shifting-brush motors, variable-speed gears, or hydraulic couplings when A.C. motors are used. Owing to the small speed range of commercial D.C. electric motors, air speeds are also regulated by adjusting outlet dampers or fan inlet guides.

Brush-shifting motors have a speed range of 15 : 1, but are bulky and expensive. Steam drives give adequate speed ranges.

(6) Fuel supply to chain grates is regulated by stoker speed, fire thickness (fire thickness should be kept constant over as wide a range of speeds as possible, as every change of thickness reduces combustion efficiency until it is completed), or by intermittent drive. Furnace pressure control eliminates the effect of fuel bed resistance on combustion rate. For pulverised fuel the control is by feeder speed and primary air.

(7) Fuel-air ratios can be altered at will on most systems. Electric contacts are made reliable by the use of Mercoid switches, mechanically operated relays, Thyratron tubes, and other devices.

(8) Hydraulic relays are based on the ordinary piston valve, the Tag leak, the Arca leak, the Askania deflected jet, and the Kent-Hodgson intercepted jet. Of these, the piston valve is apt to stick unless it is power operated from one of the other types of relay.

(9) Boilers may be controlled in groups, or individually raised or lowered in rating.

(10) There are two main types of control, those which merely adjust air flow and water feed to meet demand, and those which in addition attempt to proportion fuel and air feeds so as to obtain the highest permissible CO_2 values at each load.

(11) Though almost every boiler control catalogue declares that the particular system described "keeps *the pressure* constant," only two control systems actually attempt to keep the receiver pressure constant. All the other systems definitely allow it to fall, and base the operation of their control mechanisms on its fall.

(12) "Hunting" of the controls is avoided by various methods. Among these are simple damping (as in the case of furnace pressure control); sending a series of small time impulses and waiting until each impulse has produced its full effect; using stabilisers (these limit the speed of response); sending timed impulses which depend upon both deviation and rate of deviation (positive or negative), and the use of "follow-up" devices which gradually cut out the control impulse as the desired condition is obtained.

(13) The avoidance of hunting also presupposes quick and finely graded response to the controls. Thus in the case of D.C. fan motors the studs on the shunt rheostat controls should either be very numerous or the dampers should be readjusted between each stud position.

In the case of twin fans one fan should be controlled and the other should follow it. Forward-bladed and radial-bladed fans cannot be run in parallel owing to the flatness of their pressure delivery curve over the range of maximum efficiency.

When more than one fan is used an automatic safety device should be provided at each fan outlet to close a damper in case of failure. This prevents air blowing back through the stationary fan.

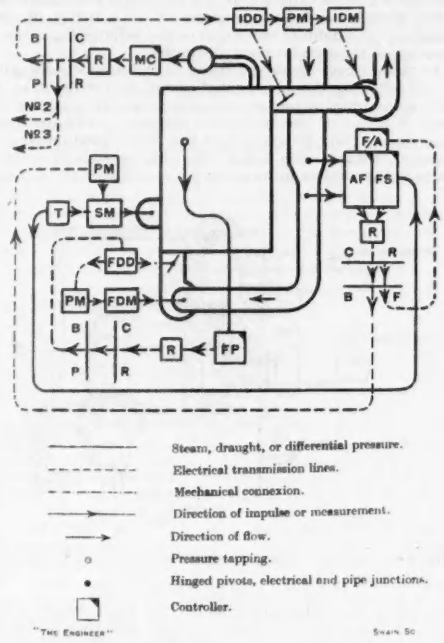
(14) The jerky motion of air-operated pistons and the slow and somewhat uncertain speed control of hydraulic couplings as at present designed makes their use unsuitable when rapid and accurate control is desired.

(15) The "value" of automatic control is to prevent smoke, to maintain load against demand, to carry out routine adjustments, to facilitate group control of boilers, to increase thermal efficiency by tireless and ever-watchful operation (the continuous adjustment within small limits effected by automatic control must increase efficiency even in the case of base-load stations). Also in many cases automatic control, by providing limit switches and other protective or cut-out devices, greatly facilitates the safe handling of the plant.

(16) Control methods and devices are rapidly becoming standardised. Flexibility of adjustment, ability to maintain any desired relation or condition, and ease in changing over from automatic to push-button or to hand control are among the most important desiderata. Automatic control and the provision of automatic or interlocking safeguards are commonplaces on the electrical side of a power-house. There would seem to be no reason why such aids should not be equally commonplace, and of even greater value, on the steam generation side.

The Kent Electrical System.—This system is interesting as being the first successful automatic combustion control system of British design and manufacture. It aims at keeping the receiver pressure constant. Its chief distinctive features are the control of each function in sequence, instead of the control of several functions simultaneously, or by allowing them to interact and readjust themselves; and the method of avoiding hunting of the particular controls (the induced draught damper and the fan motor rheostat) which are operated from the master regulator. Other novel features are that it allows overriding of the signals of the master regulator, or the altering of any of the controls by push-button from the control room or from the panel at the boiler front without switching off, and of manually adjusting the controls of each boiler from the boiler front, where the various indicators are situated, without disconnection or switching off. Switching off is provided for where necessary. The fuel-air ratio for each load is provisionally determined by a cam, and this ratio can be altered on any furnace in accordance with the CO_2 readings by push-button control from either the control room or from the boiler front, the actual fuel-air ratio setting being shown on a dial at each of these positions. The system also allows the rating of any boiler to be raised or lowered.

Fig. 1 shows diagrammatically the control measurements taken, and the directions of the electrical impulses



AF Air Flow Controller.
BC Controller for Individual Boiler.
BP Panel at Boiler Front.
CR Panel in Control Room.
F/A Fuel-Air Ratio Controller or Combined Controller and Regulator.
FDD Forced Draught Damper Operating Mechanism.
FDM Forced Draught Fan Motor.
FP Furnace Pressure Controller or Combined Controller and Regulator.
FR Forced Draught Regulating Mechanism.
IDD Induced Draught Damper Regulating Mechanism.
IDM Induced Draught Motor.
MC Master Controller.
PM Pilot Motor Controlling Rheostats, or Combined Pilot Motor and Rheostat.
PR Primary Air Regulating Mechanism.
R Electrical Relay.
SM Stoker Motor.
T Tachometer.

FIG. 1—*Diagram of Kent Electrical System as Applied to Boilers Fired by Mechanical Stokers.*

and the mechanical drives. It will be noticed that the air flow is measured in the duct immediately after the heater and not across the boiler passes.

As applied to a group of boilers fired by mechanical stokers the sequence of operations is as follows:—A change in the receiver pressure, operating through the master controller, alters the induced draught of all the boilers in the group so as to tend to bring it back to its steady value. This alteration of the induced draught upsets the furnace pressure, which is automatically readjusted by independent controllers operating the forced draught. The new air flow thus established through each furnace is

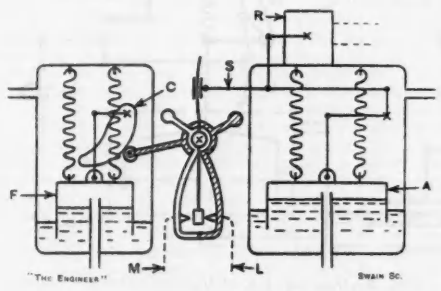


FIG. 2—*Diagram of Fuel-Air Ratio Device.*

measured by suitable means and the fuel flow balanced against it.

The adjustment of the forced and the induced draught is by controlling the speeds of shunt-wound D.C. fan motors by means of field rheostats. This control is used down to 40 per cent. of the maximum speed of the fans. At lower air flows the dampers are adjusted. In order to avoid "jumpy" control the field rheostats are provided with 200 studs. The controls automatically "throw-over" from the fan damper and back again. Limit switches are provided to prevent the rheostat arms or the dampers being moved beyond their proper travel.

The ratio of fuel flow to air flow at each load is provisionally determined by a cam contained in the fuel-air ratio controller, and, as above stated, this ratio can be altered by push-button from both the control room and the boiler front. This adjustment of the fuel-air ratio has also been used to alter the length of the fires for minor changes of load, thus saving the labour of adjusting the guillotines which control fire thickness.

The Kent fuel-air ratio controller is shown diagrammatically in Fig. 2. A is an oil-sealed bell, which, at Hackney, measures the difference of pressure across a constriction in the air duct. F is a second oil-sealed bell which measures the pressure produced by a fan tachometer driven by the stoker motor. M and L are the "more" or "less" contacts, and S is the arm of a Stephenson link mechanism which is raised or lowered by the repeater

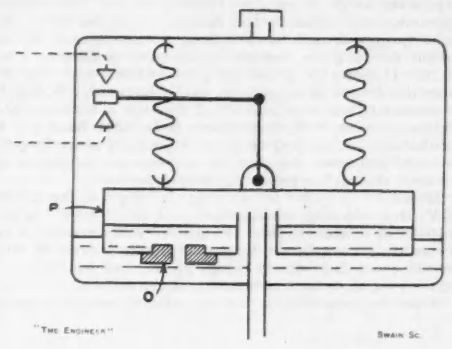


FIG. 3—*Diagram of Kent Furnace Pressure Controller.*

motor R so as to adjust the ratio of fuel to air. C is the cam which provisionally determines the percentage of excess air at each load. It will be noted that the oil-sealed bells A and F are carried by springs as is also the oil-sealed bell of the furnace pressure controller shown in Fig. 3. These springs save the use of knife edges and counterweights. The oil-sealed bell P of the furnace pressure controller is shown damped by means of the orifice O, the size of which is such as to give the damping required.

The action of the Kent master controller is illustrated approximately by Fig. 4. The line A B represents the level receiver pressure which it is desired to maintain, and

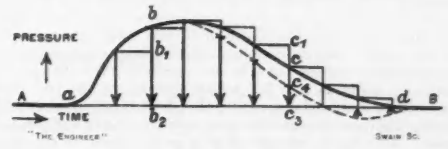


FIG. 4—*The Kent Control Curve.*

the curve $a\ b\ c\ d$ a temporary deviation from it. If the pressure is measured at equal intervals of time (say, every twenty seconds), the distances of points such as b and c from the line A B will represent the "pressure deviation" at the end of the time intervals indicated, while the lengths of the lines $b\ b_1$ or $c\ c_1$ will represent the change of pressure during these time intervals, that is, the positive or negative "rates of pressure deviation."

The mechanism of the Kent master controller is so

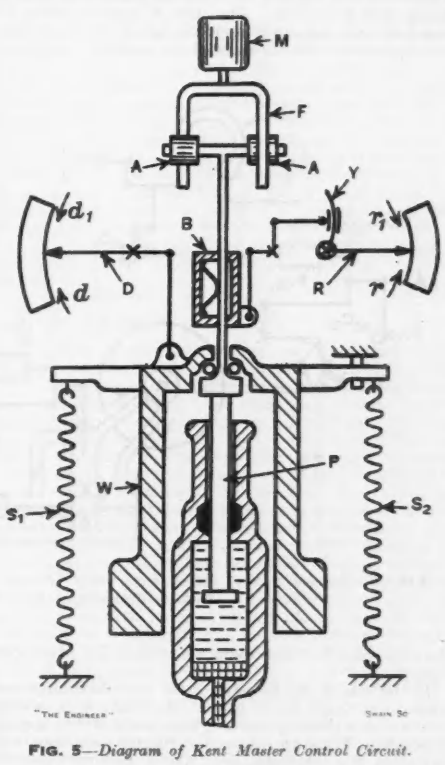


FIG. 5—*Diagram of Kent Master Control Circuit.*

arranged that when the "deviation" and the "rate" are of the same sign, time impulses proportional to whichever is greater are sent out, but that when they are of opposite sign, the time impulses sent out are proportional to their differences. The duration of the time impulses sent out during the two intervals considered will therefore be proportional to $b\ b_2$ and $c_4\ c_3$, where $c_4\ c_3$ is equal to the difference between $c\ c_2$ and $c\ c_1$. The control impulses are therefore diminished as soon as the pressure tends to

return to its desired steady value, being gradually cut out altogether or reversed as this value is approached.

By altering the relative effects of "deviation" and "rate" it is possible to over-regulate while the pressure is departing from normal, and to regulate in the reverse direction so as to prevent overshooting when the pressure is returning, thus obtaining the quickest possible response.

The mechanism by which these time impulses are produced is shown diagrammatically in Fig. 5. P is a piston subjected to the receiver pressure which is rotated so as to eliminate friction by means of a motor M through the spring fork F which bears on the rollers A. This piston carries the weight W on a ball bearing thrust. This weight approximately balances the receiver pressure, while the light springs S_1 and S_2 determine the movement of the piston for a given change of receiver pressure. The pointer D shows the actual deviation of the steam pressure from the desired zero position, while the pointer R, which is actuated from the piston rod through a friction-tight sliding member S M, and which is brought back (by a mechanism not shown) to its zero position every twenty seconds, indicates the positive or negative deviation of pressure during the preceding twenty seconds.

Means are provided for altering the length of the cranks X Y, thus altering the sensitivity of the "rate" movement of R, relative to the "deviation" measurement of D. A mechanism not shown clamps the pointer D every twenty seconds, and then slowly brings up the four contacts d d_1 and r r_1—Fig. 6—in the direction of the arrows.

These four contacts operate the induced draught controls

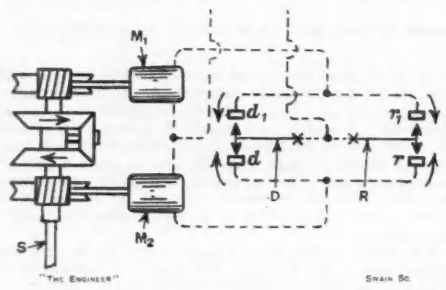


FIG. 6—*Diagram of Kent Master Control Circuit.*

for the time intervals required in the following manner. In the case of the induced draught damper controls where considerable torque has to be exerted, two identically similar motors M_1 and M_2, whose speeds are damped with identically similar fans, rotate the shaft S (which is geared to the damper spindle) through a worm-driven differential gear. The worm wheels of this gear rotate in opposite directions, so that if both motors are running the shaft S, which is driven by the planet wheel of the gear, remains stationary; while either motor running by itself drives the shaft in the appropriate direction. This arrangement enables motions corresponding to time intervals of a fraction of a second to be made with great precision.

The time interval during which the D contacts are made depends upon the actual displacement of the arm D at the moment when contact is made by d or d_1, that is, upon the pressure deviation; while the time interval during which the R contacts are made depends upon the time required to push the arm R back to its middle position after contact is made at r or r_1, that is, upon the change of pressure during each time cycle. The shaft S is thus rotated for time intervals depending upon deviation or rate (whichever is greater) when these are of the same sign, and upon the difference between them when they are of opposite sign.

In the case of the rheostat of the induced draught fan, where only small forces have to be dealt with, a single continuously running motor drives two shafts in opposite directions. These are clamped by magnetic clutches to the two sides of a differential gear, and a shaft corresponding to the shaft S in Fig. 6 raises or lowers the slider arm of the rheostat.

The Kent Hydraulic System.—In the Kent hydraulic system as applied to boilers fired by mechanical stokers and provided with forced draught, the position of the induced draught damper or the speed of the induced draught fan is related to a definite fall in the receiver pressure; the furnace pressure is controlled by an independent unit, and the rate of fuel feed is adjustably related to the air flow through each furnace.

In those cases where the induced draught fan is coupled to a constant-speed motor through a hydraulic coupling a fall in the receiver pressure causes a Bourdon tube B—Fig. 7—to operate the intercepted jet mechanism C_1 so that there is an increase of fluid pressure in the Sylphon bellows B_1. This increase in pressure actuates a second intercepted jet mechanism C_2, which increases the pressure in a second Sylphon bellows B_2 and so causes a considerable increase in the supply of fluid to the hydraulic coupling. This in turn causes the speed of the induced draught fan, which is connected to the coupling, to increase rapidly. The fan speed measured by the centrifugal weight tachometer T reverses the movement of the intercepting plate of C_2 and so decreases the pressure in B_2 as the speed called for by B is approached. The use of a float F connected through a further differential link mechanism ensures that there shall be a definite amount of oil actually in the coupling for a definite extension of the bellows B_2. Overshooting of the speed is thus prevented.

In those cases where the speed of the induced draught is controlled by damper, field rheostat, motor rheostat or A.C. communtator motor, a piston-operated controller is used in place of the hydraulic coupling controller just described. Fluid pressure from the intercepted jet mechanism C_1 actuates the bellows B_3—Fig. 8—which in turn operate the duplex intercepted jet mechanism C_3 through

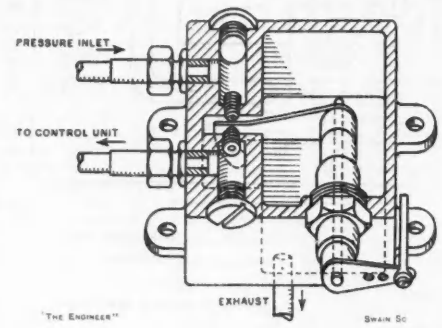


FIG. 10—*Diagram of Kent-Hodgson Intercepted-Jet Mechanism.*

the follow-up mechanism shown. This delivers fluid under pressure to one side or other of the operating piston P, which is thus made to move in accordance with the change of pressure in B_3. A cam C enables any desired relation between fall of receiver pressure and of the damper position to be allowed for.

One of the elements of the unit for controlling stoker speed where hydraulic couplings are used is shown in Fig. 9. Here a fall of pressure across the boiler passes operates an oil-sealed bell O which operates the intercepted jet mechanism C_2, and so controls the pressure maintained in the Sylphon bellows corresponding to B_2 in Fig. 7. The tachometer T_1 which actuates the follow-up mechanism in this case measures the stoker speed. A cam M allows the coal and air ratio to be made different at each load, while the Stephenson link L enables it to be varied at any load. Modifications of this device can be used to operate a rheostat or brush-shifting gear.

The Kent-Hodgson intercepted jet mechanism which is the basis of the hydraulically operated Kent system is shown in Fig. 10. In this mechanism a small jet of fluid (air, water, or oil) is discharged at a steady pressure of about 15 lb. per square inch. The impact of this jet is capable of forcing fluid under pressure into a pipe connected to the nozzle, and this pressure may be held at any desired value lower than its maximum by intercepting the jet with a thin plate. If the axis of the intercepting plate is parallel to the jet, there is practically no reaction on the plate, and small forces from Bourdon tubes and the like are capable, by means of this intercepted jet relay, of controlling quite large power pistons without the use of a "step-up" relay—although this may be used when great quickness of response or exceptionally large power is desired. In order to obtain reverse motion the controlled pressure may operate against a spring force, as in the case when a Sylphon bellows is used. Or two pairs of jets controlled by one intercepting plate, as shown in Fig. 8, may be used.

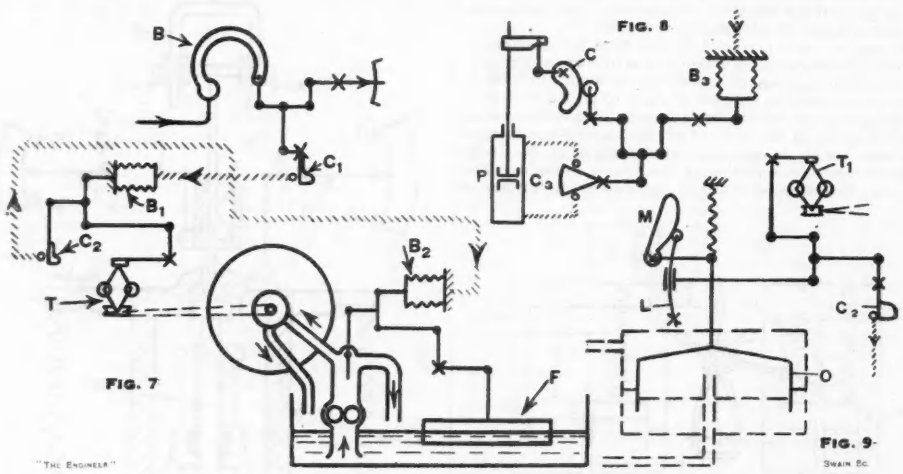


FIG. 7—*Diagram of Kent Hydraulic Coupling Control.* FIG. 8—*Diagram of Kent Hydraulic Damper Control.*
FIG. 9—*Diagram of Kent Hydraulic Fuel-Air Ratio Control.*

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

RADIOVISOR PARENT, Ltd., London, has received from the Mersey Tunnel Joint Committee a contract for apparatus which will observe automatically the visibility in the tunnel, and record it at the central control room.

WILLIAM BOBY AND CO., Ltd., have received orders for their lime-soda softeners from the London and North-Eastern and Southern Railway Companies as follows:—For the London and North-Eastern Railway, a plant to be erected at King's Cross Station, having a daily capacity of 960,000 gallons; for the Southern Railway, a plant to be erected at the railway company's Lancing Works, with a daily capacity of 36,000 gallons.

MIRRLEES BICKERTON AND DAY, Ltd., inform us that amongst the more important orders recently received for "Mirrlees-Diesel" engines are a three-cylinder, 360 B.H.P. at 250 r.p.m. engine driving a pump by ropes, for the Battersea pumping station; this set will form part of the equipment which is being installed owing to the recent drought. A five-cylinder engine of 655 B.H.P. at 273 r.p.m., driving a 375 kW generator, for the Madura Electric Supply Company, and smaller engines for Shri Gajanan Weaving Mills, Ltd., the Veraval Electricity Works, State of Junagadh; the electric power station, Raichur, Hyderabad State; Trivandrum; Wardha Municipality; and the Pedro Estate, Ceylon. One five-cylinder and one three-cylinder engine are being sent to Australia, and a six-cylinder, 450 B.H.P. engine, to drive a 300 kW G.E.C. generator, for the Barbadoes Electric Supply Corporation. Amongst marine engines there are two three-cylinder, 62 B.H.P. engines for Admiralty Indian sloops, and one six-cylinder, direct-reversing engine of 120 B.H.P. at 340 r.p.m. for propulsion of the War Office barge "John Adams," and two 60 B.H.P. "Mirrlees-Ricardo" high-speed (1200 r.p.m.) engines for a target-towing tug.

LAUNCHES AND TRIAL TRIPS.

AAGTEKERK, twin-screw motor ship; built by Netherland Shipbuilding Company, Ltd., to the order of Messrs. N. V. Vereenigde Nederlandsche Scheepvaartmaátschappij; dimensions, 493ft. by 60ft. by 40ft.; to carry passengers and cargo. Oil engines, Stork-A.E.G.-Hesselman type; constructed by Gebrs. Stork and Co.; trial trip, January 23rd.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

DR. J. DONALD POLLOCK has been appointed chairman of the board of directors of the British Oxygen Company, Ltd., and Mr. P. B. Liversidge, chairman of the management committee of directors.

MR. R. J. VENN, M.I. Chem. E., who, since 1928, has been on the staff of the Dorr Company, and later the Dorr Oliver Company, has resigned from this company in order to join the chemical engineering department of Davey, Paxman and Co. (Colchester), Ltd.

THE VACUUM OIL COMPANY has received official notification from the Keeper of the Privy Purse that it has been awarded the Royal Warrant as purveyors of oil and grease to His Majesty the King. The Vacuum Oil Company was established in Liverpool in 1886 and was incorporated as a limited company in 1901.

CATALOGUES.

MANLOVE, ALLIOTT AND CO., Ltd., 41 and 42, Parliament-street, S.W.1.—A descriptive booklet of the firm's sterilising equipment installed at the Royal Masonic Hospital.

WHESSOE FOUNDRY AND ENGINEERING COMPANY, Ltd., Darlington.—A new brochure on the firm's processes for the removal of fog, mist, dust, fumes, &c., from air and industrial gases.

A. C. WICKMAN AND CO., Ltd., Coventry.—Catalogue sheets Nos. W.1 and W.2, which deal with the British-made "Forst" vertical broaching machine and the "Wagner" cold sawing machine.

RANSOMES, SIMS AND JEFFERIES, Ltd., Ipswich.—A booklet illustrating and describing the various types of trolley omnibuses supplied for town and suburban transport in various parts of the world.

BURTON, GRIFFITHS AND CO., Ltd., Montgomery-street, Sparkbrook, Manchester.—A pamphlet illustrating the various drills, taps, dies, milling cutters, and small tools made by B.S.A. Tools, Ltd., for whom the firm acts as distributors.

THE LATE MR. A. J. BOLTON.—We regret to announce the sudden death, on January 22nd, of Mr. Arthur John Bolton, aged fifty-five years. Mr. Bolton had completed thirty years' service with the General Electric Company, Ltd., and since 1930 was assistant secretary of the Electrical Development and Securities Trust, one of its subsidiary companies.

INSTITUTION OF ELECTRICAL ENGINEERS.—The outstanding features of the annual dinner of the North-Western Section of this Institution, which was held at the Midland Hotel, Manchester, on Tuesday, January 23rd, were a record attendance of over 300 and the hopefulness of the speeches. The toast of "The Institution of Electrical Engineers" was proposed by Sir Andrew R. Duncan, Chairman of the Central Electricity Board, who said he had recently made a tour of the district where he had found among the leaders of the industry enthusiasm and vitality. The electrical industry had made great strides and he believed that expansion was going to take place in directions so varied that no man could foresee them. The toast was acknowledged by Mr. P. V. Hunter, the President of the Institution. The toast of "Our Guests" was proposed by the Chairman, Mr. G. G. L. Preece, who expressed the hope that Sir Andrew Duncan would have the co-operation of supply engineers and of the manufacturing industries in the work which he had undertaken. Sir William Ray, Chairman of the Electrical Development Association, who responded, attributed the improvement in the public health to the engineers rather than to the medical profession, and he looked to the electrical industry to give us a pure atmosphere. He hoped in the near future that manufacturers would make an effort towards the standardisation of appliances, as had already been done in regard to voltages and frequencies. The toast of "The Chairman" was proposed by Dr. S. L. Pearce.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Course of Business.

The demand for most descriptions of finished materials has slackened during the past week or so. This may mean that the volume of buying that has been maintained for several months has passed its zenith; but the market is disinclined to accept this view and believes that it is no more than a temporary pause. Uncertainty regarding the future arising from the changes foreshadowed if the steel makers' reorganisation scheme is adopted, doubts regarding the stability of the Continental position, and the substantial contracts placed since Christmas are all exercising an influence upon the position. The latter is probably the chief factor in the slowing down of business, as many stockholders have replenished their holdings of steel and for the time being are off the market. The belief that the first effect of the National Committee's scheme will be to raise prices has stimulated buying, and this is recognised by the steel makers. Upon the question of prices the market is divided. It must be remembered that the quotations for the controlled descriptions of steel have not been altered for four years, the increases which have taken place during the past year having been confined to re-rolled products and to those sizes for which the steel makers have always allowed a free market. On the other hand, consumers and dealers regard the prospects of a general price increase with apprehension on the grounds that it will restrict business. In support of this argument they point to instances in the past when an advance in prices has been followed by a period of bad trade, and argue that the history of the British steel trades is full of such cases of cause and effect. The steel makers generally review prices and other matters at the quarterly meetings, but the one usually held towards the end of the year was postponed, and probably no change will be made until the industry has adopted or rejected the reorganisation scheme. Nothing certain can be known on this point until towards the end of February.

The Pig Iron Market.

The feature of this market is the steady dispersal of the heavy stocks, which, only a few months ago, were weighing upon the market. First, the Cleveland makers sold out their accumulations, and for some time have been hard pressed to meet their customers' requirements. Next the producers of hematite on the North-East Coast announced that they had little unsold iron left on their hands. The difficulty of securing Cleveland iron diverted the demand to the Northamptonshire makers, and it is now said that the producers in this district are sold as far forward as they care to go, and, as a consequence, there has been something in the nature of a run on Derbyshire pig iron. There are certainly considerable accumulations of the latter iron in the makers' hands, but it may be supposed that recent history will shortly repeat itself, and it will be announced that Derbyshire iron is scarce. The Cleveland makers have heavy commitments, and are finding it difficult to distribute their production amongst their customers. Whilst the official prices are usually quoted some consumers have been obliged to pay premiums for prompt delivery. The starting of a furnace on foundry iron has not appreciably eased the position. There is no doubt that the demand for pig iron is expanding in most districts. In Lancashire, where the demand has rather hung fire, substantial increases in the tonnages ordered are reported. The light castings industries in that district and in Scotland continue to take good quantities, and there has been a distinct improvement in the demand from the general and engineering foundries. The price position is somewhat puzzling. There is no doubt that the producers are in a position to enforce an increase, but there would be vigorous protests from consumers. The market, however, has been expecting an advance for some time, particularly as the price of coke has appreciably increased, the minimum quotation for good Durham blast-furnace coke being now 22s. 6d. delivered. Probably some of the pig iron makers have large stocks, but with the market rising against them they are adopting a cautious policy in regard to increasing their output. Preparations are being made to increase the number of blast-furnaces in operation, and when this is done the position all round may become easier. In the meantime, the payment of premiums may bring about a rise in the actual prices, although the official quotations remain unaltered.

Scotland and the North.

Most of the activity in the Scottish iron and steel trades is due to specifications received from the shipyards, at which there is now a fair amount of work in progress. The Admiralty orders for four destroyers have been divided between Fairfields and Alexander Stephen and Sons, the cost totalling £1,200,000. The plate mills are more active than they have been for some time as a consequence of the busier conditions at the shipyards, and although so far there has been no obvious results in the way of orders from the understanding with the Continental ship plate producers, there are hopes that soon foreign shipbuilders will be in the market. Constructional engineers are less busy than they were in the autumn, but the general engineering firms have good order books and provide a steady outlet for a substantial tonnage of steel. Most of the re-rolling works are only moderately employed, and this section of the industry complains of the quantity of foreign steel bars which are reaching Scottish consumers in spite of the duties. The home quotation for small steel bars is held at £7 15s., and for export £6 17s. 6d. to £7 is quoted. The tone of the market in Lancashire has become firmer of late, and the volume of business has increased. A feature of the situation is the reluctance shown by some manufacturers to accept forward contracts, and this is attributed to their belief that if the reorganisation scheme comes into force prices will be established on a higher level than at present. There is no doubt that a heavy tonnage of steel has been bought in anticipation of increased prices, and it is not surprising that manufacturers are disinclined to let this movement go too far. Producers of plates continue to complain of the scarcity of orders; but most mills are working at a fair rate and occasionally there is a spurt in business in this material. Constructional engineers in this district have been busier of late, although there is still room for improvement in the amount of work which comes on the market, particularly in the way of large contracts. Business in special steels and alloy steels is active, and the demand seems likely to continue for a long time. Re-rollers are experiencing a strong demand, and in some cases have advanced their quotations to £7 15s., although it is still possible to place business at £7 12s. 6d. The volume of orders reaching the works on the North-West Coast has declined a little of late; but the steel works have sufficient orders on their books to keep them busy for a few months. The recent orders for ships awarded to builders in this district also gives an assurance of fresh business in the near future.

The Midlands and South Wales.

There has been a quieter tone in the Midland iron and steel market of late, which, in part, may be attributed to some nervousness occasioned by the prospect of drastic changes in the marketing of steel as a result of the reorganisation scheme. Stockholders, also, have largely replenished their stocks, which probably stand at a higher level than for some years past, and, therefore, are not buying so much. Notwithstanding the lighter demand for small bars and similar material, the re-rolling works in the Midlands are being hard pressed to keep their deliveries to time. The price of small steel bars is firmly held at £7 10s., but there is no doubt that an increasing number of buyers are turning again to similar Continental material, which they can buy at £6 15s. 9d. delivered, and including duty. This can hardly be a satisfactory price for Continental makers, since it works out at only £2 17s. 6d. (gold) f.o.b. Antwerp, or, in sterling, £4 6s. 3d. In strip the difference in prices is also marked, the British quotation of £8 5s. to £9 10s., according to description, comparing with a Continental price of £7 15s. to £8 10s. The demand for strip, however, has been so well maintained that the home producers seem scarcely affected by foreign competition, and their order books are kept well filled with fresh business. Some users of strip state they have to place a certain amount of business abroad because they require Thomas basic steel strip for their particular work. The Midland constructural engineers are not particularly well off as regards work on hand, and this is reflected by a quieter demand for joists and sections. This branch of the industry is inclined to blame the reluctance of public bodies to embark upon improvement schemes for the comparative scarcity of important orders. On the whole, however, the industry is better off than in December. Conditions in South Wales are not altogether satisfactory, as the demand for tinplates does not improve. Recently there has been rather more buying, and business on a fair scale has been done with Canada, Australia, and the Continent. Competition from foreign makers in the export markets is severe, and negotiations are proceeding in the hope of reaching an international understanding regarding markets and prices.

The North-East Coast and Yorkshire.

Generally speaking, conditions are satisfactory on the North-East Coast. There is, of course, idle plant, but with an occasional lull, such as has been experienced this week, the general tendency is for the demand to improve. The sheet department is an exception to this rule; but producers of this material in all districts are experiencing a poor demand. The requirements of home consumers have dwindled of late, although this may be a temporary lull, and export business has failed to develop. In the East, British makers have lost a considerable amount of business lately to the Japanese, who have accepted extraordinarily low prices. The Indian market, also, has been almost stagnant, and under the agreement between the Tata Iron and Steel Company, Ltd., and the British manufacturers, most of the little business available has gone to the Indian producer. Business in structural steel has been fairly well maintained, but many of the orders reaching the works are for small quantities. Nevertheless, the structural engineers provide a steady outlet for steel, although, perhaps, they do not take quite such good quantities as a few months ago. The shipyards on the Tyne are less busy than those on the Clyde, and the demand for shipbuilding steel is, therefore, only relatively good; but the ship-repairers are well employed, and provide a substantial amount of work for the steel makers. In the Yorkshire district active conditions rule, and business in the high-class steels produced in the Sheffield district is particularly good. For instance, the demand for stainless steel, which weakened a short time ago, recovered before the output of the producing works was affected. The orders coming to hand are principally for stainless steel sheets, and the volume of trade has grown considerably since the autumn. Apparently makers expect a continuation of the demand, and preparations are being made to increase the plant in operation. Makers in this area report that business in alloy steels has not been so good of late, but, considering the quantities sold towards the end of last year and this month, a lull was about due. Re-rollers in this area are disturbed at the possible effects the reorganisation scheme may have upon their position, and are exercising caution in quoting for forward delivery. The demand for steel bars, however, is strong, although not so insistent as it has been; but there has been no diminution in the demand for strip, which is keeping all the works well employed and some fully occupied.

The American Steel Industry.

An interesting survey of conditions in the American iron and steel trade under the operation of the "Code" has been issued. It is in the form of a statement by the Executive Secretary of the American Iron and Steel Institute, the Directors of which constitute the "Code" authority. He states that from last June till November, which is the latest month for which figures are available, the direct outlay for wages, exclusive of salaries, for the steel industry showed an increase per ton of finished steel products of 70 per cent. In November, with production down by 40 per cent., wage earners were paid 400,000 dollars more than in June, whilst in November the average hours of labour were about 27·8 per week, compared with 39·4 in June. Before the Code, any considerable increase in volume of output would automatically cut down the wage outlay per ton. This will be less true henceforth, because of the Code restriction in respect to maximum hours and minimum wage. With a 70 per cent. operation it is estimated 125,000 more men would have to be added to steel mill payrolls. It is claimed that there is one basis price for all users, and secret price concessions cannot put one buyer at a competitive disadvantage with another in the same line. The Code, it is argued, has brought the whole price situation into the open. Members of the Code are compelled to list their prices with the American Iron and Steel Institute. This is simply a method of making prices public, but it does not fix prices. Under this system the price filed by a Company becomes the publicly announced figure for that company, and any change cannot be made except by filing a new price. Other producers are sure to meet that bid if their production costs permit. The natural tendency, therefore, is towards a uniformity of prices which comes about because each company is determined to meet the lowest offer of its competitor. The result is that the price is no longer as powerful a factor in selling steel as was formerly the case. Sellers are now emphasising quality of product, convenience of delivery, services which may legitimately be performed for the consumer, and like considerations.

Copper and Tin.

Business in copper, although rather better than in the early weeks of the year, has not been on a sufficiently large scale to create confidence in the position. Consumers are bare of stocks, but still show reluctance to buy forward and most of the business which has been transacted has been for near delivery and in some cases for metal ex stock. The situation causes some nervousness in the market, since it is felt that if the American copper "code" should result in the establishment of higher prices it might cause a rush of buying. The copper required might not then be immediately available and, as has occasionally happened in the past, a period of panicky buying by consumers and dealers might create artificial conditions which are inevitably followed by a time of bad trade and low prices. There is no doubt that at the present moment electrolytic copper is cheap, and a comparatively small buying movement would probably be reflected quickly in higher values. The London standard market also has been busier and there has been a fair amount of buying by dealers. Speculators have shown more interest in the market, a good proportion of the buying coming from the Continent. . . . Steady conditions have characterised the tin market for some weeks past and little of interest has developed to arouse either speculators or consumers. At this season of the year business in this market is usually quiet, but it is perhaps surprising that the movements of the dollar-sterling exchange have not brought out more buying from the United States or from the Continent. The proposal to institute a "buffer" pool, which would hold 8000 tons of tin, to regulate prices on the London market has received a check, as the Council of the Federated Malay States Chamber of Mines has voted against it.

Lead and Spelter.

No feature of interest has developed in this market over the week. Considerable quantities of lead are passing into consumption through the battery makers and manufacturers of lead pipes and sheets, but the demand from the cable makers has not been good. Business on the Continent is said to have declined somewhat, but this is probably only a temporary lull, such as usually occurs about this time of the year. The low price of the metal should stimulate the demand, but consumers generally wait until the market shows an inclination to rise before covering their requirements. Brandeis, Goldschmidt and Co., in their annual report, estimate the world's production in 1933 as 1,161,000 tons, compared with 1,148,000 tons in 1932 and 1,397,000 tons in 1931. Interesting figures relating to consumption are given, the quantity credited to the United States in 1933 being 310,000 tons, compared with 850,000 tons for the rest of the world. In 1932 the figures were 284,000 tons and 813,000 tons respectively. . . . The active demand for spelter, which has been expected for so long, fails to develop. Recently, however, there has been a strong demand for Empire spelter, and as much as 10s. per ton has been paid for these brands over metal produced in foreign countries. There has been some tightness in the market, which is of a technical character, and frequently develops at the end of the month. Recently a small quantity of Belgian spelter was declared on the London market, which was the first metal to be received from that country for a considerable time. It is interesting to note that the production of spelter last year appears to have increased compared with that for 1932. The annual report of Brandeis, Goldschmidt and Co. gives the production for 1933 as 985,000 tons, compared with 781,000 tons in 1932 and 995,000 tons in 1931.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Hematite Mixed Nos.	3 2 6	3 0 0
No. 1	3 3 0	3 0 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	3 5 0	—
MIDLANDS—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 6	—
Basic	3 10 0	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	3 6 0	—
N.W. COAST—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow; 4 0 6 „ Sheffield; 4 5 6 „ Birmingham	

(*Basic iron prices subject to a rebate of 5/–.*)

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
LANCS.—		
Crown Bars	9 0 0	
Best Bars	9 10 0	
S. YORKS.—		
Crown Bars	9 15 0	
Best Bars	10 15 0	
MIDLANDS—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. COAST—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
LONDON AND THE SOUTH—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	7 10 0	—
Plates, ¾in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 7 6	8 5 0
NORTH-EAST COAST—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 7 6	7 0 0
Plates, ¾in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 2 6	8 5 0
Boiler Plates, ¾in.	8 5 0	7 12 6
MIDLANDS, AND LEEDS AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 10 0	7 0 0
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 2 6	8 5 .0
Boiler Plates, ¾in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
GLASGOW AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 15 0	7 0 0
Plates, ¾in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
SOUTH WALES AREA—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	7 10 0	7 0 0
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 7 6	8 5 0

IRELAND—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	7 10 0	8 0 0
Plates, ¾in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	8 15 0	8 15 0
14-G. to 20-G., d/d	10 0 0	9 0 0
21-G. to 24-G., d/d	10 5 0	9 5 0
25-G. to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/3 to 16/6.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic, Soft (25·41% C.)	6 0 0
„ Medium (0·42% to 0·60% C.)	6 17 6
„ Hard (0·61% to 0·85% C.)	7 7 6
„ „ (0·86% to 0·99% C.)	8 7 6
„ „ (1% C. and up)	8 17 6
Soft (up to 25% C.), 500 tons and up	5 5 0
100 tons	5 12 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/9 per lb.	
Ferro Tungsten	2/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 12 6	7/–
„ „ 8 p.c. to 10 p.c.	£21 12 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 10 0	9/–
„ „ „ 1 p.c. carbon	£35 12 6	10/–
„ „ „ 0·70 p.c. carbon	£37 10 0	12/6
„ „ „ carbon free	10½d. per lb.	
Metallic Chromium	2/8 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 7 6 scale 5/– p.u.	
„ „ 75 p.c.	£17 0 0 to 17 10 0 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/6 per lb.	

NON-FERROUS METAL.

Official Prices, January 31st.

COPPER—		
Cash	£33 11 3 to £33 12 6	
Three months	£33 13 9 to £33 15 0	
Electrolytic	£36 10 0 to £37 0 0	
Best Selected Ingots, d/d Birmingham	£37 5 0	
Sheets, Hot Rolled	£64 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10d.	10d.
„ Brazed (basis)	10d.	10d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
„ Brazed	11d.	11d.
TIN—		
Cash	£226 5 0 to £226 10 0	
Three months	£225 15 0 to £226 0 0	
LEAD:	£11 6 3 to £11 8 9	
SPELTER:	£14 16 3 to £14 18 9	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

		Export.
LANARKSHIRE—		
(f.o.b. Grangemouth)—Navigation	Unscreened	13/3 to 13/6
„ Glasgow—	Ell	14/– to 16/–
„ „	Splint	16/6 to 17/–
AYRSHIRE—		
(f.o.b. Ports)—Steam		12/9 to 13/–
FIFESHIRE—		
(f.o.b. Methil or Burntisland)—Steam		14/– to 14/3
Unscreened Navigation		12/6 to 13/–
LOTHIANS—		
(f.o.b. Leith)—Hartley Prime		13/9 to 14/–
Secondary Steam		13/3 to 13/6

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	17/6 to 20/6
Furnace Coke	13/– to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	14/– to 14/6
„ Second	13/– to 13/3
„ Best Small	10/6 to 11/–
Unscreened	12/– to 13/6
DURHAM—	
Best Gas	14/8
Foundry Coke	17/– to 19/6

SHEFFIELD—	Inland.
Best Hand-picked Branch	27/– to 28/–
South Yorkshire Best	22/– to 24/–
South Yorkshire Seconds	17/6 to 19/6
Rough Slacks	6/– to 9/–
Nutty Slacks	7/– to 8/6
Furnace Coke (at ovens)	12/3

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/–
Foundry Coke	21/– to 36/–
Furnace Coke	18/6 to 20/–
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm	9/6 to 10/6
Steam Coals:	
Large	18/– to 20/–
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ¼d. per gallon extra

French Engineering Notes.

(*From our own Correspondent in Paris.*)

Master Artisans.

THE importance of giving a legal definition to the class of master artisans lies in the fiscal privileges they enjoy, privileges which can only be preserved by excluding makers who are not entitled to them. Moreover, the artisan community is anxious to extend its influence for the protection of small producers whose number is stated to be somewhere near 1,300,000. A law was passed a few years ago authorising the creation of Chambres de Métiers to represent master artisans. There are now forty such Chambers. The generally accepted definition of an artisan was that he should work on his own account with the aid of not more than ten helpers and apprentices. It was also understood that he should sell his products direct to consumers. There are, however, 120 industries carried on by master artisans, who work under a great variety of conditions that make it difficult to fix a general maximum of men to be employed. The individual labour production varies in different crafts, so that while ten helpers could be accepted in some trades that number would be excessive in others. It is because of this uncertainty as to what constitutes an artisan in particular trades that many small manufacturers employing more than the allotted number of men have been able to associate themselves with the artisan class of producers, and there was some fear that the Chambres de Métiers would lose their distinctive character and find themselves in conflict with the Chambers of Commerce. It was therefore necessary to fix a legal limit to the number of helpers that would qualify a small maker to be classed as a master artisan. The idea of a general limit for all crafts had to be abandoned. A law has now been passed entrusting the Minister of Labour with the task of fixing the maximum number of helpers and apprentices employed by those qualified to be master artisans in the different trades and crafts, after consultation with the professional associations representing them, as well as with the Chambres de Métiers. In no case will the number of helpers exceed ten.

The Proposed Exhibition.

During the past three years a commission has been engaged in making preliminary arrangements for the holding of a great exhibition in Paris in 1937. The preparatory work should have entered upon an active phase this month, when invitations to participate in the exhibition were to be sent to all nations. Its main object was particularly interesting at a time when the whole world is endeavouring to find a solution of its industrial problems. Primarily an exhibition of arts and crafts indigenous to country regions, it would obviously have tended to a revival of local industries that would give a national character to a country's productions. It would have helped in the work of industrial decentralisation. The exhibition was to have been the largest and most attractive held in Paris since 1900. Laid out on both sides of the Seine and extending beyond the old Paris boundaries, it would have comprised permanent constructions, including a bridge across the river flanked by two palaces, one to be used eventually as an art gallery and the other as a centre of development of international trade. The scheme appears to have fallen through. Neither the State nor the Paris Municipality can afford to incur the financial obligations necessary for the success of the exhibition. A final decision will be reached at a Cabinet meeting shortly, but it is believed that the whole affair will be abandoned, unless it is preferred to reduce considerably the importance of the exhibition or to postpone it for a few years.

Imports of Sample Machines.

An objection to high import duties for the protection of home industries is that they tend to stifle progress by isolating the home market from the benefit of technical improvements carried out abroad. In the new fiscal legislation provision is therefore made for the free importation of sample machines of an entirely new character, or possessing notable improvements, that may be required by manufacturers of similar classes of machines for the purpose of examining them with a view to their construction in this country. The manufacturer needing a machine must make formal application for permission to import it without payment of import duty, and the demand will be examined by the consulting committee of the Conservatoire des Arts et Métiers. If the committee's report is favourable the required permission will be granted under certain conditions restraining the importer from using the machine for his own productive work, while he must allow of its inspection by anyone who may be interested in it. The idea of this special exemption from the payment of import duties on machines of new types is to enable French manufacturers to produce similar machines, but the demand for them on the home market is usually too limited to allow of their production under economical conditions, so that the buyer is not able to profit from the lower costs enjoyed by his foreign competitors.

Foreign Trade.

The returns of foreign trade during 1933 are remarkable for the heavy depreciation of values which leaves a considerable deficit in the balance of exchanges, though alike in imports and exports there were increases in tonnage, mainly in "material necessary for industry," a somewhat elastic classification which covers raw material and partly finished products. The total value of imports was 28,425 million francs, or 1383 millions less than in 1932, despite an increase in volume of 866,500 tons. The exports valued at 18,433 million francs were 1272 million francs less than in the previous year, but the tonnage increased by 1,432,183, mainly attributable to iron ore, blooms and billets and similar products. In this latter category an increase of 1,016,167 tons was accompanied by a rise in value of 184 million francs, while the exports of manufactured goods showed an increase of 384,211 tons and a decline of no less than 1057 million francs. There was a much less marked decrease in the colonial trade, the figures of which are included in the returns.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

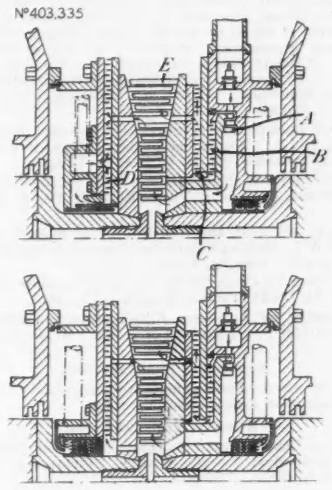
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date at the end of the abridgment, is the date of the acceptance of the complete Specification.

TURBINE MACHINERY.

403,335. August 8th, 1933.—RADIAL FLOW TURBINES, *H. G. Cruikshank Fairweather*, 65, *Chancery-lane, London, W.C.2.*

This turbine is of the radial flow opposed rotation type and has a high-pressure wheel on one side only at A. The out-of-balance end pressure on the shaft thus produced is counteracted

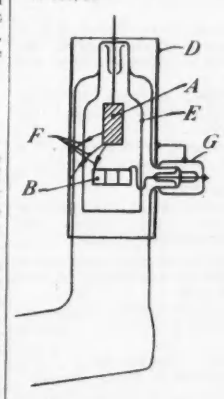


by the steam pressure in the labyrinth packings B C D, which, it will be seen, have appropriately proportioned areas. Some of the steam leaking through the packings is conducted into the low-pressure blading, there to give up its energy.—*December 21st*, 1933.

TRANSFORMERS AND CONVERTERS.

403,126. May 24th, 1933.—HIGH-VOLTAGE RECTIFIERS HAVING GLASS BULBS, Société Anonyme Hewittic and Marcel Demontvignier, both of 11, Rue du Pont, Suresnes, France.

The construction of glass bulb gas or vapour-filled rectifiers for obtaining high rectified voltages presents difficulties when it is proposed to exceed 3000 to 4000 volts per bulb. Above this limit there is an ageing phenomenon consisting in the spontaneous elevation of the starting voltage of the anode. Furthermore, it has been observed that, on sudden variations of load of the rectifier, disturbances are produced on the cathode spot. These various phenomena are all due to an extension of the electric field of the anode. According to the invention, the anode A and the grid B are surrounded by an external conducting screen D, which completely envelops it. The grid B, fixed to the inner glass guiding sleeve E, is connected electrically to the screen D and is supplied by a suitable source of potential. The screen D is, of course, thoroughly insulated from the anode to which the high potential is applied. Under these conditions, the high electrostatic fields which may arise from the anode are insulated in the Faraday cage formed by the grid B and the screen D, and if the anode A is at any moment strongly positive with respect to the cage, it can only emit lines of force, such as F, which cannot produce negative electrification of the inner parts of the arm, since in these regions ionisation is very feeble before starting. The starting tension of the anode cannot therefore tend to rise. It has been assumed that the tension applied to the anode is insufficient for the lines of force which it emits to traverse the grid or pass round the screen. For higher potentials, further precautions must be taken to avoid these phenomena. The grid must be closed and the screen prolonged upwards. The outgoing conductors from the grids are electrostatically screened by means of metal hoods G.—*December 15th*, 1933.



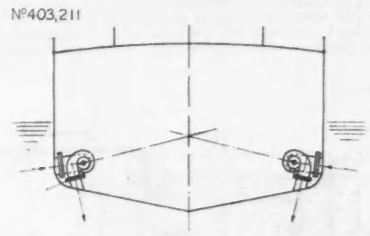
SHIPS AND BOATS.

403,162. July 22nd, 1932.—ELECTRIC SHIP PROPULSION ARRANGEMENTS, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2; and Bernard Shire, of the General Electric Company, Ltd., Engineering Works, Witton, Birmingham; and Clement Philip Harrison and Charles Wallace Saunders, both of the General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2.

In electric ship propulsion arrangements in which inner and outer propellers are arranged to be driven by different electric motors adapted to receive power from the same source it is found that with similar propellers driven at the same speed the power absorbed by an inner propeller is greater than the power absorbed by an outer propeller. This is probably due to the wake or wash of the outer propeller affecting the operation of the inner propeller, and the motor driving the inner propeller is more heavily loaded than the motor driving the outer propeller. As a result at intermediate speeds the former motor is heated to a greater extent than the latter motor, while at full speed the former motor is overloaded and the latter motor is underloaded. According to the invention, in an electric ship propulsion arrangement the inner and outer propellers are arranged to be driven by different alternating current electric motors adapted to receive power from the same source. The pole numbers of these motors are different and the speed of an inner propeller is less than the speed of an outer propeller, so that the load distribution between the motors is improved. The motors are synchronous machines adapted to start as asynchronous motors. Power for the motors is provided by two alternators and the starboard motors may be connected to one alternator and the port motors to the other alternator, or all four motors may be connected to either of the alternators. If desired, one alternator may be connected to the inner port and starboard motors and the other alternator to the outer port and starboard motors.—*December 21st*, 1933.

403,211. October 24th, 1932.—MINIMISING THE ROLLING OF SHIPS, W. L. Bazé, 29, rue Tronchet, Paris.

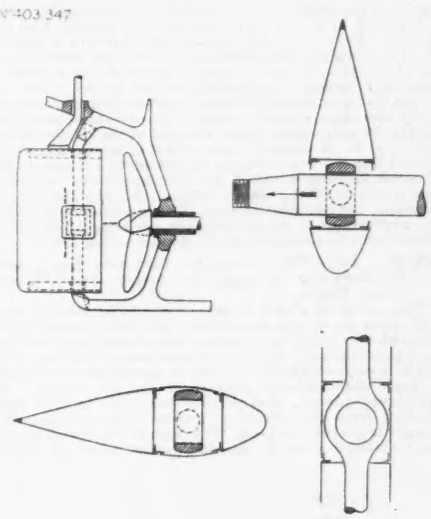
The inventor proposes to reduce the rolling of ships by the reaction of water jets provided by centrifugal pumps in the bilges. The pumps are so placed that the centre line of the



inlet points towards the centre of gravity of the ship, and the outlet is normal to this line. The pumps are kept running continuously, and the jets are controlled appropriately to the rolling by valves operated electrically from a gyroscope.—*December 21st*, 1933.

403,347. November 8th, 1933.—STERN POSTS, Fried. Krupp Germaniawerft Aktiengesellschaft, Kiel-Gaarden, Germany.

In the case of single-screw ships with the engines placed right aft, it is difficult to withdraw the tailshaft inwards on account of the obstruction of the engine, and it cannot be pulled outward if the stern post is in the way. The trouble is overcome by the inventors in the following manner:—The rudder post is provided at the level of the tail shaft with an eye correspond-

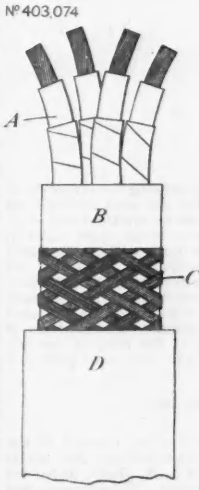


ing in size to the diameter of the tail shaft. The rudder post and eye are enclosed by a pivoted balance rudder of streamline form, the maximum width of which is determined by the size of the eye. Closeable openings are provided in the side walls of the streamline rudder at the level of the tail shaft, which lie, when the rudder is laid transverse to the direction of travel of the ship, in line with the tail shaft and eye.—*December 21st*, 1933.

TRANSMISSION OF POWER.

403,074. June 6th, 1932.—ELECTRIC CABLES, Croydon Cable Works, Ltd., of Mitcham-road, Croydon, Surrey, and John Henry Chilcote Brooking.

This invention relates to electric power cables of the kind which have considerable flexibility in combination with resistance to hard usage, such as are used, for instance, as trailing cables in mines. It is usual to construct such cables with a sheathing of tough vulcanised rubber and to embed in this sheathing fine wires in the form of a braid or a helical wrapping disposed so as to serve as a screen surrounding the conductors and provide protection electrically, and in some cases mechanically. Owing to the small size of the individual wires, of which such protective screens are formed, and owing to the treatment to which such cables are subjected, it is found that the protective screen may be seriously affected by the sulphur present in the adjacent vulcanised rubber and the screen thereby rendered ineffective. The object of the invention is to overcome this trouble. There are four cores A insulated with flexible insulation, such as rubber, vulcanised or unvulcanised. The cores are embedded in a sheath of unvulcanised material B, and over this there is a screen C of fine wires in the form of a tubular braid, and this screen is covered on the outside with a further sheath D of unvulcanised material similar to the layer B. The unvulcanised material of the layers B and D may consist of a mixture, the principal constituent of which is rubber, and which also includes asbestos fibre and carbon black. The additional constituents give

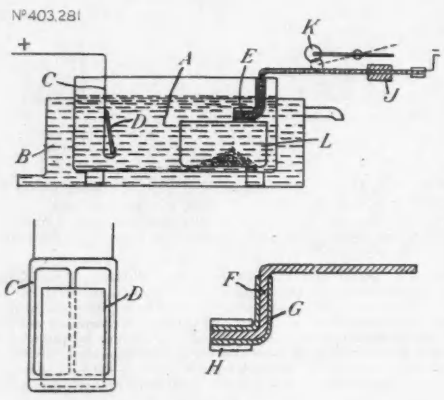


toughness. A cable constructed in accordance with this invention has the additional advantage that it is comparatively easy to repair the part which is most liable to suffer damage.—*December 6th*, 1933.

MISCELLANEOUS.

403,281. April 27th, 1933.—METHODS OF OBTAINING PURE METALLIC COBALT IN POWDER, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych London, W.C.2.*

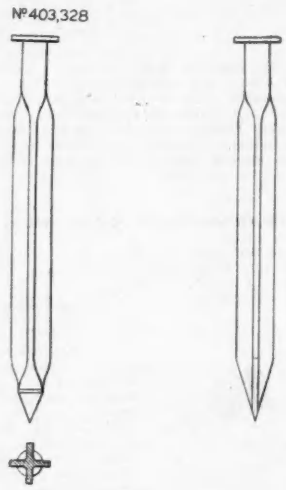
The process described in this specification is claimed to give perfectly pure cobalt in a powder of the desired grain. This process consists essentially in the electrolysis of a solution of a cobalt salt, preferably pure sulphate, the current density at the cathode lying within a range from 500 to 5000 ampères per square decimetre, according to the size of the grain required, and the concentration of cobalt salt. The temperature of the electrolysis should vary preferably between 40 deg. and 60 deg. Cent. The electrolytic vat A is placed in a vat B with water circulation to maintain the temperature at the requisite degree. C is the platinum anode, which forms a perforated basket carry-



ing one or more plates D of pure cobalt. The aluminium cathode E is formed by a bent aluminium wire F, surrounded up to its extremity by a rubber tube G, and provided with a glass tube H. The straight section of the cathode is alone in contact with the electrolyte. A rubber stopper J supports the cathode. A hammer K causes the cathode to vibrate by the effects of its shocks, and is controlled either by a cam or by an electromagnet, or by any other suitable means. The receptacle intended to receive the pulverulent cobalt detached at the cathode is represented by L. A preferred composition of the electrolyte comprises 1 litre of a 40 per cent. by weight solution of pure sulphate of cobalt in water, to which has been added 1 cc. of pure sulphuric acid at 66 deg. Baumé (about 1·82 gm.) and 60 c.c. of saturated tartaric acid solution. The invention extends to all the applications of cobalt prepared according to the process which forms its essential object.—*December 21st*, 1933.

403,328. July 26th, 1933.—AN IMPROVED NAIL, Société Etablissements Robergel, 45, Avenue Foch, Vincennes (Seine), France.

This invention relates to nails of which the shank is formed with wings with a view to increasing its contact surface with the material into which it is driven, and consequently the resistance to extraction. In order to manufacture the nail, a start can be made from a blank along which there alternate cylindrical portions and cruciform portions of suitable lengths. Each cylindrical portion, after having been cut at the desired distance from the cruciform portion which succeeds it, is swaged to provide the head. The point of the preceding nail is itself obtained either by pressing the remainder of this same



cylindrical portion or else by cutting or shaping the extremity of the cruciform portion of this nail. For the same resistance to extraction, the nail is of a weight distinctly less than that of an ordinary nail. It provides a resistance of the same order to bending, by reason of the development of the wings in the radial direction. Its driving in and its extraction can be effected like those of an ordinary nail. Its head is in effect sufficiently stout to support the blow of the hammer, and its short distance from the part provided with wings gives to it a strength which resists its bending under the blow of the hammer. The existence of a cylindrical portion in the vicinity of the head of the nail allows of engaging below the latter the usual nail pullers.—*December 21st*, 1933.

INSTITUTION OF NAVAL ARCHITECTS.—The Council of the Institution of Naval Architects has awarded the gold medal for the year 1933 to Engineer-Captain S. R. Dight, R.N., for his paper on "Naval Water-tube Boilers: Experiments and Shop Trials," and the premium to Mr. George Hughes, B.Sc., Ph.D., of the William Froude Laboratory, for his paper on "The Effect of Wind on Ship Performance." The medal and the premium will be presented at the opening of the annual general meetings on Wednesday, March 21st next, at the Royal Society of Arts, John-street, London, W.C.2.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

FARADAY HOUSE OLD STUDENTS' ASSOC.—At Midland Hotel, St. Pancras, N.1. Annual dinner, dance. 7.30 p.m. to 1 a.m.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN STUDENTS.—Armstrong College, Newcastle-upon-Tyne. The Students' Lecture, "Domestic Electrical Apparatus from an Engineering Point of View," Mr. F. H. Clough. 7.15 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND CENTRE.—Royal Victoria Hotel, Sheffield. Dance, 7.30 p.m. to 1 a.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting, discussion introduced by Mr. H. G. Mitchell on Production. 7 p.m.

INST. OF MINING ENGINEERS.—At Rooms of Geological Soc., Burlington House, Piccadilly, W.1. Annual general meeting. Presentation of Medal to Mr. H. Eustace Mitton. Discussion, "Sheathed Explosives," Messrs. C. A. Naylor and R. V. Wheeler; "Safety Lamps for Use by Underground Officials," Captain C. B. Platt; "*Draft* Standard Specification for the Testing of Mine Fans." 11.15 a.m. Luncheon, 1 p.m. Meeting resumed, 2.15 p.m.

INST. OF PRODUCTION ENGINEERS: LONDON SECTION.—83, Pall Mall, S.W.1. "Control of Quality in Hardening and Heat-treatment Processes," Mr. H. H. Beeny. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Salvage and Disposal of Town Refuse," Mr. A. E. Clouds. 7.30 p.m.

PHYSICAL SOC.—At Imperial College of Science and Technology, S.W.7. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.; meeting, 5 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse by Lord Conway of Allington. 9 p.m.

UNIVERSITY OF LONDON.—King's College, Strand, W.C.2. "Apparatus for Power Factor Correction," Mr. D. B. Hoseason. 5.30 p.m.

SATURDAY, FEBRUARY 3RD.

INST. OF CIVIL ENGINEERS.—Students' visit to L.P.T.B. railway works at Acton. Morning visit.

MONDAY, FEBRUARY 5TH.

BRADFORD ENGINEERING SOCIETY.—Technical College, Bradford. "Individual Electric Driving," illustrated by lantern slides, Mr. A. Brier. 7.30 p.m.

CHARTERED SURVEYORS' INST.—12, Great George-street, S.W.1. Meeting, 8 p.m.

ENGINEERS' GERMAN CIRCLE.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Neuere Grosswerkzeugmaschinen und ihre Verwendung (Modern Heavy Machine Tools and their Use)," Herr Dr.-Ingenieure H. Haake, Professor an den Technischen Staatslehranstalten, Hamburg. 6 p.m.

INST. OF PRODUCTION ENGINEERS: SHEFFIELD SECTION.—Royal Victoria Hotel, Sheffield. "Heavy Machine Shop Practice," Mr. J. H. Garnett. 7.30 p.m.

SOC. OF CHEMICAL INDUSTRY.—At Chemical Soc., Burlington House, W.1. "Recovery of Benzol by Activated Carbon," Messrs. H. Hollings and S. Hay. 8 p.m.

TUESDAY, FEBRUARY 6TH.

ELECTRO-DEPOSITORS' TECHNICAL SOC.: MIDLANDS CENTRE.—James Watt Memorial Inst., Birmingham. Mr. E. J. Dobles will open discussion, "Nickel Plating Troubles." 7.30 p.m.

INST. OF AUTOMOBILE ENGINEERS.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "Aero Engine Design," Capt. G. S. Wilkinson. 7.45 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Discussion, "Water Supply of Kano, Northern Nigeria," Mr. H. J. F. Gourlay; "Uniform Flow in Alluvial Rivers and Canals," Mr. G. Lacey. 6 p.m.

INST. OF PRODUCTION ENGINEERS: EASTERN COUNTIES SECTION.—At Ipswich Public Library, Ipswich. "Jig and Tool Design," Mr. E. J. H. Jones. 7.30 p.m.

STEPHENSON LOCOMOTIVE SOC.—King's Cross Station, N.1. "Single-wheeled Engines," Mr. A. G. Williamson. 6.30 p.m.

WEDNESDAY, FEBRUARY 7TH.

INST. OF ELECTRICAL ENGINEERS: WIRELESS SECTION MEETING.—Savoy-place, W.C.2. "Velocity-modulation Television System," Messrs. L. H. Bedford and O. S. Puckle. 6 p.m.

INST. OF CIVIL ENGINEERS: STUDENTS.—Great George-street, S.W.1. "Electric Arc Welding and its Application to Steel Structures," Mr. R. J. Fowler. 6.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS: GRADUATES.—Bolbec Hall, Newcastle-upon-Tyne. "Superheating," Mr. D. Tagg. 7.15 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C. "The Human Element in Industry," Mr. Robert R. Hyde. 8 p.m.

SOC. OF GLASS TECHNOLOGY: LONDON SECTION.—Visit to Scrub's-lane depôt of United Dairies, Ltd. 7.30 p.m.

THURSDAY, FEBRUARY 8TH.

INST. OF AUTOMOBILE ENGINEERS.—At Merchant Venturers' Technical College, Bristol. "Aero-engine Design," Capt. G. S. Wilkinson. 7 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. "Hydro-Electric Power Developments on the Rhine," Mr. H. E. Gruner. 6 p.m.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOC.—At James Watt Memorial Inst., Birmingham. Vernon Harcourt Lecture, "Canals," Mr. J. A. Sauer. 6 p.m.

INST. OF ELECTRICAL ENGINEERS.—Grosvenor House, Park-lane, W.1. Annual dinner and reunion. 7 p.m.

INST. OF MARINE ENGINEERS: JUNIORS.—The Minories, E.C.3. Debate, "Coal *v.* Oil Fuel for Steam Raising." 7 p.m.

INST. OF METALS: LONDON LOCAL SECTION.—At 83, Pall Mall, S.W.1. "Electric Annealing and Heat-treatment Furnaces," Mr. A. G. Lobley. 7.30 p.m.

ROYAL AERONAUTICAL SOC.—Meeting postponed.

FRIDAY, FEBRUARY 9TH.

INST. OF METALS: SHEFFIELD LOCAL SECTION.—In Applied Science Dept., The University, Sheffield. "Recovery and Refining of Precious Metals," Mr. H. G. Dale. 7.30 p.m.

INST. OF PRODUCTION ENGINEERS: WESTERN SECTION.—At Merchant Venturers' College, Bristol. "Psychological Aids to Increased Production." Dr. G. H. Miles. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Honorary Member's Lecture, "Thunder Storms, Magnetic Storms, and Wireless Transmission," Professor E. V. Appleton, F.R.S. 7.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—In Mining Inst., Newcastle-upon-Tyne. "Auxiliaries for Marine Engine Installations," Mr. P. L. Jones. 6 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, "Reminiscences of Physics and Physicists," Sir Joseph Thomson. 9 p.m.

SATURDAY, FEBRUARY 10TH.

INST. OF MARINE ENGINEERS (JUNIOR SECTION).—85/88, The Minories, E.C.3. Social and dance. 7.30 p.m. to 11.15 p.m.

MONDAY, FEBRUARY 12TH.

INST. OF METALS: SCOTTISH LOCAL SECTION.—At 39, Elmbank-crescent, Glasgow. "Combustion Efficiency," Mr. J. A. C. Edmiston. 7.30 p.m.

INST. OF TRANSPORT.—Joint meeting with Inst. of Electrical Engineers, Savoy-place, W.C.2. "Regeneration as Applied to Electric Traction," Mr. G. F. Sinclair. 5.30 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2.—Thomas Gray Lecture, "Deep Diving and Under-water Rescue," Sir Robert H. Davis. 8 p.m.

TUESDAY, FEBRUARY 13TH.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Some Influence on a Shipowner's Choice of a New Cargo Ship," Messrs. R. R. Campbell and B. Ramsay. 7.30 p.m.

INST. OF MARINE ENGINEERS.—The Minories, E.C.3. "Turbo-electric Propulsion," Mr. C. Wallace Saunders. 6 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—At James Watt Memorial Inst., Birmingham. "Age-hardening Copper Alloys," Dr. Maurice Cook. 7 p.m.

INST. OF METALS: NORTH-EAST COAST LOCAL SECTION.—At Armstrong College, Newcastle-upon-Tyne. Annual general meeting. Chairman's Address. 7.30 p.m.

WEDNESDAY, FEBRUARY 14TH.

DIESEL ENGINE USERS ASSOC.—Caxton Hall, S.W.1. "Piston Design and Material," Mr. H. J. Maybrey. 3 p.m.

INST. OF SANITARY ENGINEERS.—Caxton Hall, S.W.1. "The Inevitable Trend of Sewage Treatment," Mr. N. Campbell Little. 6 p.m.

FRIDAY, FEBRUARY 16TH.

INST. OF CHEMICAL ENGINEERS.—Hotel Victoria, Northumberland-avenue, W.C.2. Twelfth Annual Corporate Meeting. Presentation of Medals. Presidential Address, "Chemical Engineering and the Edible Fat Industry," 11 a.m. "Modern Methods of Attacking Heat Transmission Problems," Prof. C. H. Lander, 2.15 p.m. Twelfth annual dinner, 7 p.m., for 7.30 p.m.

INST. OF TRANSPORT.—At Connaught Rooms, Great Queen-street, W.C.2. Annual dinner. 6.30 p.m. for 7 p.m.

MANCHESTER ASSOC. OF ENGINEERS.—Engineers' Club, 17, Albert-square, Manchester. Annual dinner. Reception, 6.45 p.m.; dinner, 7.15 p.m.

MONDAY, FEBRUARY 19TH.

ENGINEERS' GERMAN CIRCLE.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Schnelltriebwagen der Deutschen Reichsbahn (Fast Rail-cars on the German State Railways)," and "Mit dem Fliegenden Hamburger von Hamburg nach Berlin (With the Flying Hamburger from Hamburg to Berlin)," illustrated with kinema films, by a Technical Expert from the Deutsche Reichsbahn Gesellschaft (German State Railways). 6 p.m.

INST. OF AUTOMOBILE ENGINEERS.—At Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow, C.2. "Aero Engine Design," Capt. G. S. Wilkinson. 7.30 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2.—Thomas Gray Lecture, "Deep Diving and Under-water Rescue," Sir Robert H. Davis. 8 p.m.

TUESDAY, FEBRUARY 20TH.

ILLUMINATING ENGINEERING SOC.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Heterochromatic Photometry," Mr. H. Buckley. 7 p.m.

INST. OF AUTOMOBILE ENGINEERS.—Victoria Hotel, Wolverhampton. "Body Design for Public Service Vehicles," Mr. A. J. Romer. 7.30 p.m.

INST. OF METALS: SWANSEA LOCAL SECTION.—At Y.M.C.A., Swansea. "Cracking and Fracture of Metals with Special Reference to Service Breakages," Professor F. Bacon. 6.15 p.m.

WEDNESDAY, FEBRUARY 21ST.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN STUDENTS.—County Hotel, Newcastle-upon-Tyne. Annual dinner. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND CENTRE.—At James Watt Memorial Inst., Birmingham. "The Effective Use of Coal," Prof. R. V. Wheeler. 6 p.m.

FRIDAY, FEBRUARY 23RD.

INST. OF MARINE ENGINEERS.—Grosvenor House, Park-lane, W.1. Annual dinner. 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Some Modern Improvements in Electrical Instruments," Mr. G. F. Shotter. 7.30 p.m.

RAILWAY CLUB.—At Royal Scottish Corporation Hall, Fetter-lane, E.C.4. Annual general meeting. Presidential address, "Plymouth and Dartmoor Railway," Mr. Kenneth Brown. 7.30 p.m.

MONDAY, FEBRUARY 26TH.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND CENTRE.—At The University, Birmingham. "Applications of Automatic Voltage and Switch Control to Electrical Distribution Systems," Messrs. W. Kidd and J. L. Carr. 7 p.m.

TUESDAY, FEBRUARY 27TH.

DIESEL ENGINE USERS ASSOC.—At Pagani's Restaurant, 42/49, Great Portland-street, W.1. Annual dinner, 7 for 7.30 p.m.

WEDNESDAY, FEBRUARY 28TH.

INST. OF AUTOMOBILE ENGINEERS.—At Engineers' Club, Manchester. "Aero Engine Design," Capt. G. S. Wilkinson. 7 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "The Canning Industry," Mr. T. N. Morris. 8 p.m.

WEDNESDAY, MARCH 7TH.

STEPHENSON LOCOMOTIVE SOC.—At King's Cross Station, N.1. "A Brief Survey of Canadian Railway Systems and Transatlantic Services," Mr. A. F. Wallis. 6.30 p.m.

STEPHENSON LOCOMOTIVE SOC.: SCOTTISH BRANCH.—At Royal Technical College, Glasgow. "Railway Scenes through a Cine-Camera," Mr. H. J. Stretton-Ward. 7.30 p.m.

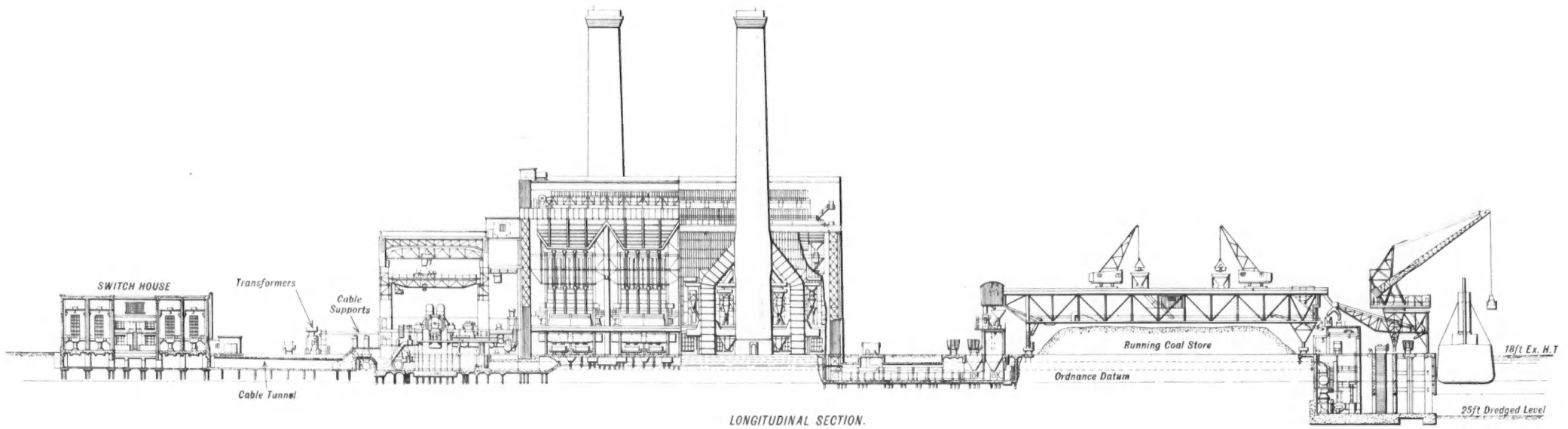
SATURDAY, MARCH 10TH.

STEPHENSON LOCOMOTIVE SOC.: MIDLAND BRANCH.—Cheetham Hill, Manchester. "Members' Photographic Night." 6.30 p.m.

MONDAY, MARCH 12TH.

ENGINEERS' GERMAN CIRCLE.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Kranbau von heute und seine Leistungen für Industrie und Verkehr: Die Entwicklung der neuen Bauformen, der Geschwindigkeiten und Leistungen, und die Bedeutung der einzelnen Krantypen für die verschiedenen Zweigen der Industrie und für den Verkehr (Modern Crane Construction and its Applications in Industry and Commerce: The Development of New Types, their Speeds and Capacities, and the Importance of Particular Types of Crane in the Different Branches of Industry and Commerce)," illustrated with lantern slides, by Herr Oberingenieur Fried. Heym, of the Demag Aktiengesellschaft, Duisburg. 6 p.m.

NEW BARKING POWER STATION—THE COUNTY OF LONDON ELECTRIC SUPPLY COMPANY, LTD.



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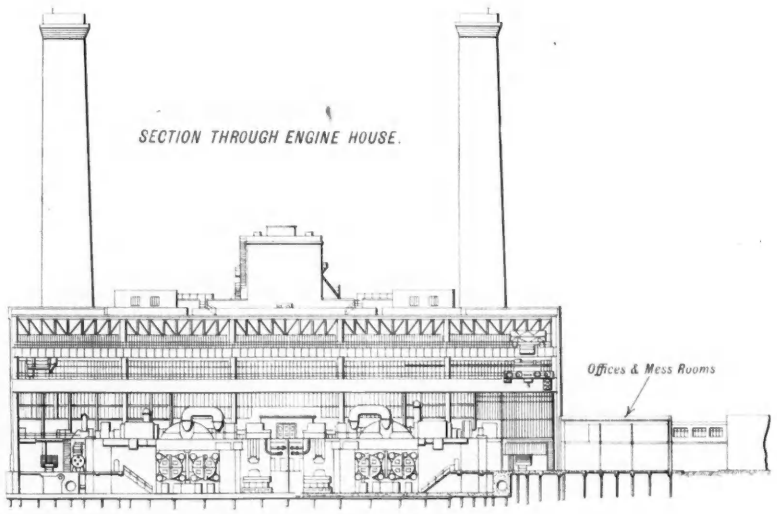

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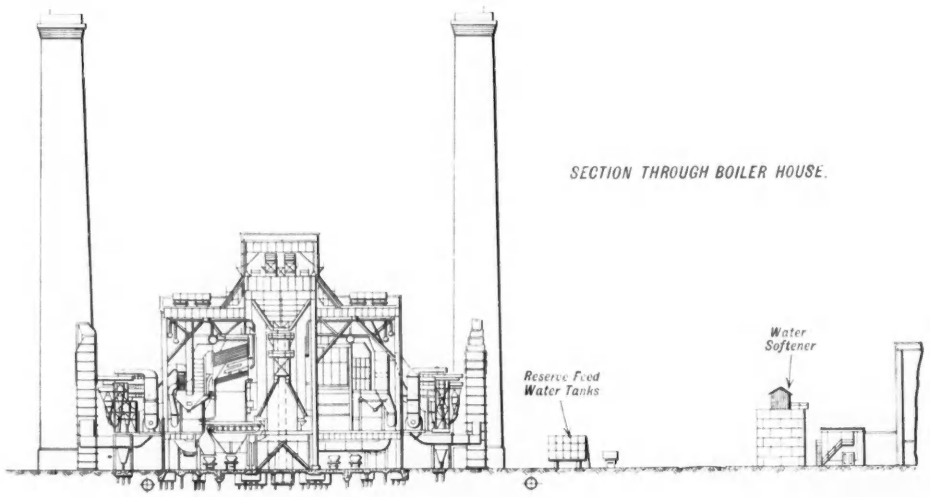

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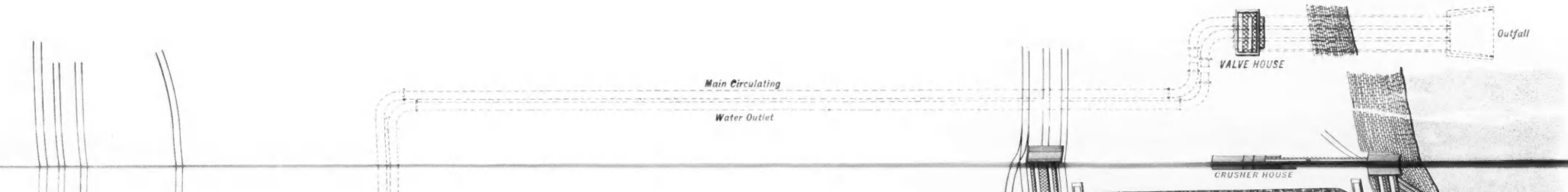
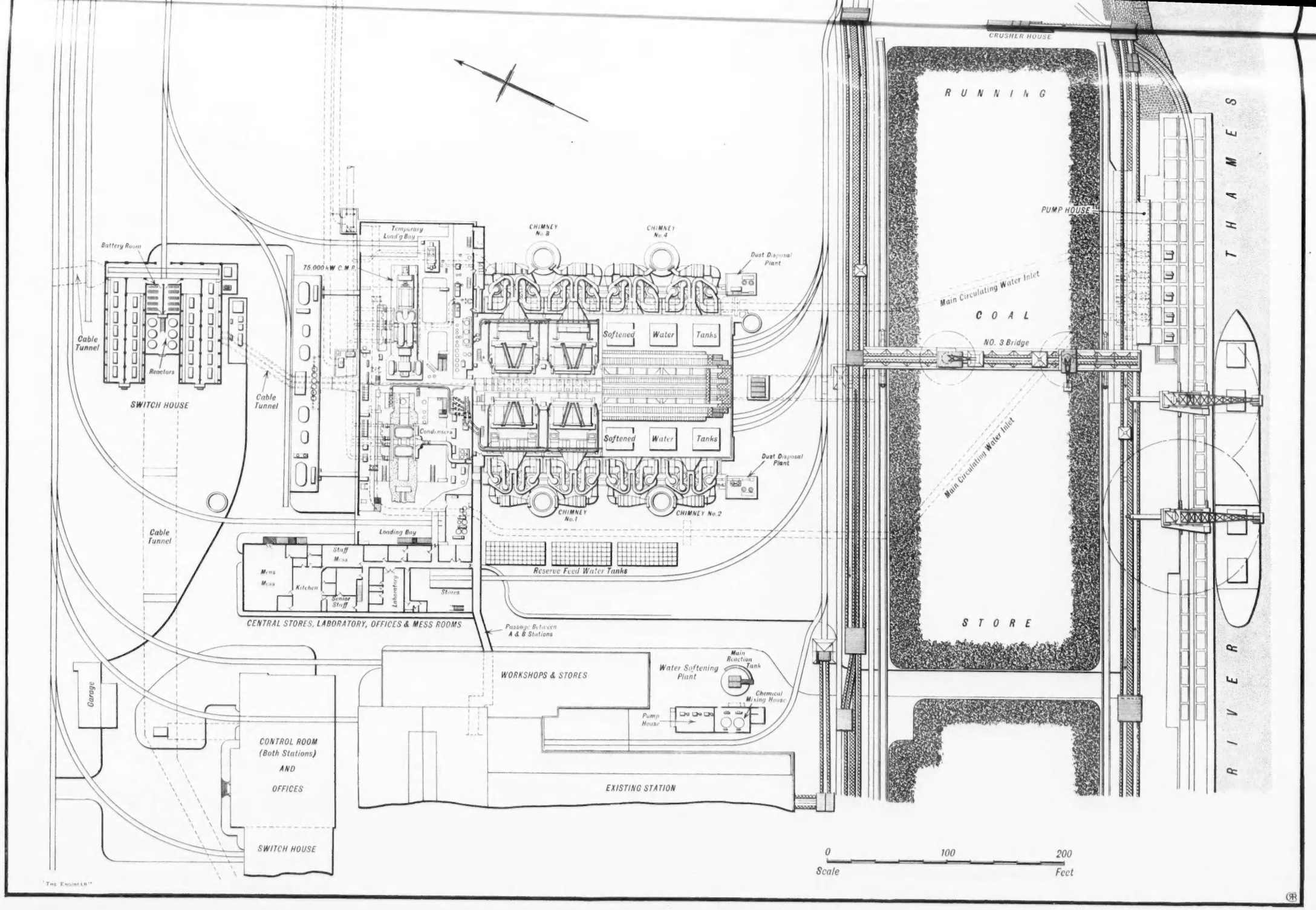




"THE ENGINEER"

A Seven-Day Journal

New Shipbuilding Orders.

IT is with pleasure that we place on record further important naval and mercantile shipbuilding orders. The Admiralty announces that, subject to the settlement of certain points of detail, it has entrusted to Yarrow and Co., Ltd., of Scotstoun, Glasgow, the building of the flotilla leader H.M.S. "Grenville," while at Greenock, Scotts Shipbuilding and Engineering Company, Ltd., is to construct one "S" class submarine, H.M.S. "Seawolf." Another submarine of the 1500 ton Porpoise class, H.M.S. "Narwhal," is to be built by Vickers-Armstrongs, Ltd., at Barrow, while the order for a sloop-minesweeper H.M.S. "Speedwell," has been placed with W. Hamilton and Co., Ltd., of Port Glasgow, the engines for which vessel will be supplied by William Beardmore and Co., Ltd., of Dalmuir. Harland and Wolff, Ltd., of Belfast, will build and engine the 5200 ton cruiser H.M.S. "Penelope." This order is specially interesting as it is the first naval order to be placed in Northern Ireland since the War. Lithgow's, Ltd., of Port Glasgow, will build a 5000 gross ton steamer for the British Phosphates Commissioners of London. On the Tees, the Furness Shipbuilding Company, Ltd., of Haverton-Hill, has received an order from Sir Joseph Isherwood, Ltd., for the construction of a 350ft., long, 60ft. beam oil tanker for the Standard Shipping Company, of New York, which will be specially designed for the South American trade of the Cia Transportadora de Petroleos, of Buenos Aires. The ship will be engined by the North-Eastern Marine Engineering Company, Ltd., of Wallsend-on-Tyne, with triple-expansion engines with cylinders 16in., 26in., and 42in. by 27in. The new tanker is to be completed within 4½ months from the placing of the order.

London's Traffic Control Lights.

THE Ministry of Transport has requested public authorities in the London district to consider the advisability of keeping the traffic control lights in the different areas in operation by night as well as by day. While some of the authorities welcome the idea of maintaining a continuous service, there are many, however, who do not see their way to do so. It is pointed out that some uniformity of practice is very desirable, especially in view of the increasing amount of traffic now using the roads at night. A real difficulty which has yet to be solved in a satisfactory way, has been encountered in the case of fixed time cycle lights, which are designed, first, to give the right of way to traffic using one road, and then that on the other road at regular intervals of time. Under conditions of night traffic, it might often occur that although there was no traffic on one of the roads served by the control lights, the traffic on the other road would, nevertheless, be held up for the full time of the cycle. That would not happen with vehicle-controlled lights, but any conversion of fixed time control systems to vehicle-operated systems would, of necessity, entail expenditure. It appears that nothing can be done towards regularising the position until the various authorities have fully examined the problem, and have expressed an opinion. The matter will be finally considered by the Ministry of Transport.

Water Pollution Research.

THE annual report of the Water Pollution Research Board, issued on Monday last by the Department of Scientific and Industrial Research, draws attention to the fact that although the water supplies of the country are, in general, much safer than those of some years ago, largely as a result of systematic research and the application of scientific methods, the need for even greater vigilance is occasionally emphasised by outbreaks of water-borne disease. The results of the survey of the river Tees, which was completed during the year, have provided information of fundamental value on the effects of sewage and various types of effluents on a river. As a result of the survey, there is no doubt that the installation of coke ovens to be erected in future in the Tees area will be so designed as to avoid the necessity of discharging any appreciable quantity of polluting effluents. Laboratories and motor boats have been equipped at Liverpool, and preliminary observations have been begun, in an important new investigation undertaken during the year relating to the deposition of silt and other matter in the estuary of the river Mersey, which has necessitated extensive dredging to preserve a navigable channel. The main object of the investigation, which is being carried out by the Department of Scientific and Industrial Research at the sole cost of the Mersey-side Local Authorities and the Mersey Docks and Harbour Board and other bodies, is to ascertain the effects of discharge of crude sewage on the character of the deposits. In view of the importance in many industrial processes, such as dyeing and steam raising, of adequate supplies of soft water, and of the fact that several water supply authorities are softening their water before it reaches the consumer, investigations are being carried out on the base-exchange process of water softening. Other important work in progress deals with the contamination of water by lead. An important survey of the existing knowledge of the subject will shortly be published, and will include sections dealing with the lead content of drinking water, the action of water on lead, electrolytic action, &c. With regard to the statement that contamination of water by lead has resulted from the leakage of electric current through service pipes, the preliminary research seems to indicate that appreciable increase in the quantity of lead in the water is unlikely unless the leakage of electrical current is unusually large.

H.M.S. Flotilla Leader "Exmouth."

ON Wednesday, January 31st, the new flotilla leader, under construction in dock at the Royal Dockyard, Portsmouth, was formally named H.M.S. "Exmouth" by Lady Kelly, the wife of Admiral Sir J. D. Kelly, Commander-in-Chief. The keel of the ship was laid down in May last and it is expected that she will be completed in November. She is one of the largest of her type now under construction for the Royal Navy and similar to the flotilla leader H.M.S. "Faulknor," to be built by Yarrow and Co., Ltd., at Scotstoun. She has a length of 339ft., with a beam of nearly 34ft. and a displacement of 1475 tons. Her geared turbine propelling machinery will have a designed output of about 38,000 S.H.P. and is designed to give her a speed of over 36 knots. This machinery, it may be recalled, is being constructed by the Fairfield Shipbuilding and Engineering Company, Ltd., at Govan, Glasgow.

Manchester's Water Supply.

A REPORT drawn up by the Waterworks Committee of the Manchester City Council, which came before the Council meeting on Wednesday, recommends the immediate resumption of the Haweswater supply scheme, which was suspended in 1931. Since work was stopped the demand for water has increased very considerably, and last year it was 56,000,000 gallons daily, which is 600,000 gallons per day above the estimated dry period yield of the Thirlmere and Longdendale works. By 1939 it is expected that the daily consumption will have amounted to 58,200,000 gallons. The Committee's scheme is a modified plan of work estimated to cost about £252,000. For the present only a small dam is to be built, but the excavations are to be made for the full width and length required for the larger dam. As further increases in demand are called for the height of the dam can then be increased. An appreciable immediate saving in capital expenditure will be made if the modified smaller scheme is adopted, compared with the larger scheme which was formerly proposed. When the works have been completed the supply of water which will then be available for the city of Manchester and for the various authorities dependent on the undertaking should be sufficient to meet all requirements for a number of years to come. Owing to the successful financial policy pursued by the Committee, aided by the fall in the rates of interest on loans, not only will the proposed new works entail no increase in charges, but, on the contrary, the Committee is in a position to recommend the reduction of certain charges as from April 1st next.

The England-Australia Air Race.

REVISED rules for the England to Melbourne air races, which are to take place in October, and for which entries close on June 1st, were issued by the Royal Aero Club last week. The sum of £10,000 is offered as prize for the open race, with a first prize of £2000 for the handicap race. The rules deal with the conditions governing pilots and aircraft, and the equipment of the machines, which, apart from scheduled halts at Baghdad, Calcutta, Singapore, Darwin, and Charleville, at distances of about 2000 miles, can be flown without restriction as to air fuelling or night flying. The handicaps will take account of the pay load, engine power, and wing area of the aeroplane in such a way as to encourage the production of high load-carrying machines of high efficiency. For the handicap race, checking points are to be established at 500-mile intervals along the route. While minor replacements will be allowed in both races at any point along the road, seals will be placed upon the engines, and any important replacement will disqualify the competitor. No entries have yet been made, but possible entries from Great Britain, Holland, and the United States have already been indicated.

The Proposed Kut Barrage.

THE Ministry of Economics and Communications of the Government of Iraq at Baghdad recently issued a preliminary notice with regard to a call for tenders for the construction of a new barrage and subsidiary works across the river Tigris at Kut. The call has now been made in accordance with specifications drawn up by the consulting engineers, Messrs. Coode, Wilson, Mitchell and Vaughan Lee, of Westminster. The proposed barrage will have a length of about 500 m., with fifty-six openings, each about 6 m. in width, which will be controlled by sluice gates. The work will be carried out in concrete and in design will be generally similar to the Nile barrages. A road, 4 m. in width, with provision for two footways, is to be constructed on the top of the barrage. In order to permit the passage of river craft, a lock will be provided on one side of the barrage. An irrigation canal, about 3 kiloms. long, with a regulator and a navigation lock, is also to be built. When the new barrage is completed it is expected that it will enable a regular supply of water to be provided in the Hai River, which flows between Nasiriyah on the river Euphrates and Kut. Drawings and specifications may be inspected in London and Baghdad, and tenders are to be submitted to the Ministry of Economics and Communications at Baghdad. They will be received up till noon on April 5th, 1934.

Waterloo and Wandsworth Bridges.

IN reply to a question put at the meeting of the London County Council, held on Tuesday, February 6th, Lieut.-Colonel J. Benskin, the Chairman of the Improvements Committee, stated that the rate of settlement of the piers of Waterloo Bridge had been continuous though not uniform throughout the year. During October and November last there was an increase in the rate of settlement for piers Nos. 2 to 6 inclusive, but within the last two months the rate had slowed down again. The actual figures were given as follows:—Pier No. 3: 1820 to November 26th, 1931, 5·04in.; November 26th, 1931, to January 29th last, 1·09in.; total since 1820, 6·13in. Pier No. 5: 1820 to 1931, 28·88in.; 1931 to January 29th last, 0·27in.; total, 29·15in. Pier No. 6: 1820 to 1931, 13·025in.; 1931 to January 29th last, 0·78in.; total, 13·805in. With regard to the reconstruction of Wandsworth Bridge, Colonel Benskin stated that a number of schemes involving a possible expenditure of about £4,500,000 were being considered by the Improvements Committee. The Wandsworth Bridge scheme was one of this number, the relative urgency of which was a question of much complexity, and had yet to be determined.

The New Cunarder.

WITHIN the last few weeks there have been reports in circulation that the construction of the new Cunard liner would be abandoned. These reports had, no doubt, their origin in what has appeared to be an undue delay in recommencing building operations. We understand, however, on good authority that negotiations for the formation of a merger company to take over the North Atlantic assets of both the Cunard and the White Star Lines have now made such progress that it will be possible for an immediate statement to be made in the House of Commons. It will be understood that the merger company will complete the new Cunarder, and that a new contract between it and John Brown and Co., Ltd., will replace that which has hitherto existed between the Cunard Steamship Company, Ltd., and John Brown and Co., Ltd. It is expected that when Mr. Chamberlain speaks, he will be in a position to communicate to Parliament the precise scheme of finance which has been adopted, which, it may be expected, will provide for the possibility of building a second ship, in addition to "No. 534" now under construction at John Brown's Clydebank yard. The statement of the Government is awaited with the keenest interest by all interested in the prestige and welfare of British shipping and shipbuilding.

The Trend in Naval Construction.

NEW tendencies in naval construction were dealt with in an address of more than usual interest given by Mr. S. V. Goodall, Assistant Director of Naval Construction, to the Southampton Master Mariners' Club last week. After outlining the technical limitations imposed by the Washington Treaty, Mr. Goodall proceeded to examine the effect of these limitations as exemplified in the design and construction of H.M.S. "Nelson," the German battleship "Deutschland," and the French battleship "Dunkerque." Concentration of armament was, he said, accepted in all three designs. The "Nelson" showed that heavy armaments and heavy protection involved a moderate speed and a big ship. On the other hand, in the case of the "Deutschland," it was seen that risks had to be accepted in respect of both protection and machinery if powerful armament and a moderately high speed were to be embodied in a small ship. Again, the design of the "Dunkerque" showed the limitations which must be imposed on both gun and torpedo armament, also that a large ship must result if high speed was to be associated with good protection. Air requirements were also shown to be a feature of the future. A careful consideration of the design of capital ships undoubtedly indicated a tendency to reduce displacement, but the reduction in offensive and defensive qualities which inevitably followed was always accepted with reluctance. In conclusion, Mr. Goodall stated that, as far as the design of large surface ships was concerned, he saw new tendencies in the concentration of main armament, the provision for aircraft both by aircraft carriers and on more combatant ships, coupled with protection against air attack and both active and passive defence.

The Development of the Parsons Steam Turbine.

No. VI.

(*Continued from page* 115, *February 2nd*).

The First Three-phase Turbo-Alternator.

THE first three-phase turbo-alternator in England, and, as far as is known, in the world, was built at the Heaton Works in 1900. Prior to that date all turbo-generators had been of the direct-current, or the single-phase alternating-current, type. It is somewhat curious that the three-phase turbo-generator, now used exclusively for central station work, did not make its first appearance in any public supply station. The honour of the introduction of the type to commercial service falls to Lord Masham, the proprietor of the Ackton Hall Colliery at Featherstone, in Yorkshire, who, in addition to much other pioneering work, was keenly interested in the development of electrically driven coal-cutting machines. He was the first man in the country to use three phase power for coal-cutting, and to obtain that power he ordered a three-phase turbo-generator from C. A. Parsons and Co., Ltd. This machine developed 150 kW at 2520 revolutions per minute. The alternator supplied current at 350 volts between phases, and at a frequency of 42 cycles per second.

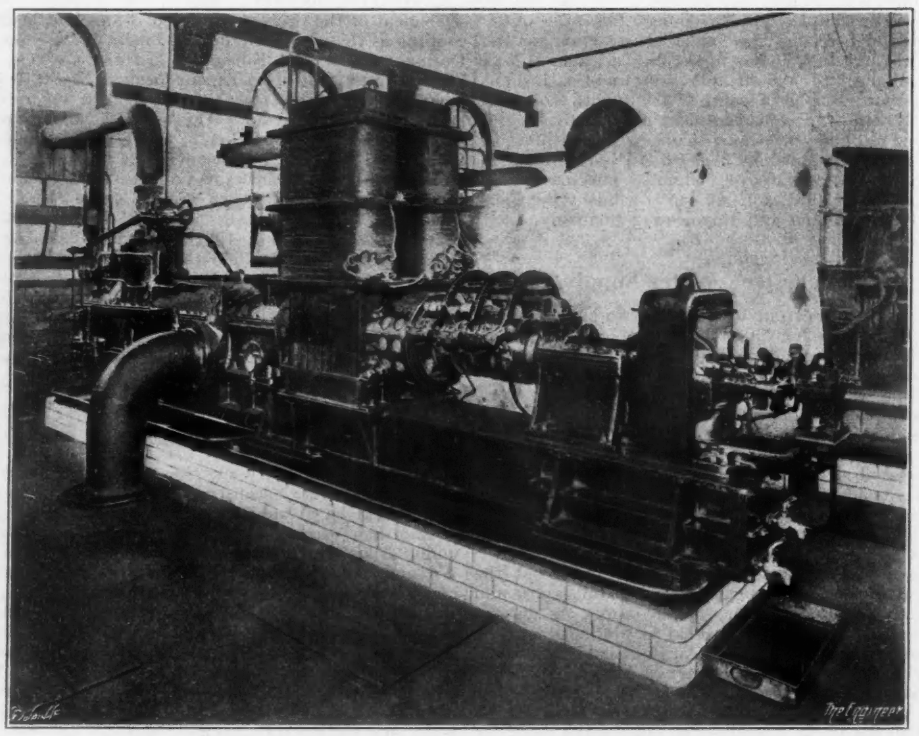


FIG. 36—ACKTON HALL 150 KW THREE-PHASE TURBO-ALTERNATOR

A photograph of the Ackton Hall unit is reproduced in Fig. 36, and drawings of the alternator are given in Fig. 37. The design and construction of the alternator followed closely along the lines of the high-speed, turbine-driven dynamos of the day. As will be seen from the illustrations, the machine had bi-polar field magnets and a revolving armature. The core of the latter was built up of laminations mounted on a solid forged steel shaft. The laminations were clamped in position by brass end rings of skeleton formation, secured by steel nuts screwed on the shaft, these rings also providing support for the end windings, which were held down by binding wire. The armature conductors, circular in form, were wound through holes near the outer periphery of the core. Another ring of holes running axially through the core, provided for the ventilation of the latter, air being drawn through them by a fan mounted at the turbine end of the armature. The armature was balanced by weights held in grooves provided for the purpose in the fan rim and in the clamping ring at the other end of the core. Current was taken from three brass collector rings, one for each phase, which were carried on a wooden sleeve mounted on tapered cones on the shaft, and locked by steel nuts.

The horse-shoe type of field magnets employed had laminated steel limbs bolted to a yoke of cast iron at the top. In the poles themselves, alternate plates were cut away and replaced by distance pieces, for purposes of ventilation. The field coils were wound on brass bobbins with end flanges of hard wood and supported from the magnet limbs by mild steel angle brackets.

The exciter was driven directly from the alternator shaft by means of a muff coupling connecting the squared ends of the shafts together with a limited amount of flexibility. The armature of the exciter was of the Gramme ring type, surface wound. The core was carried on a brass spider hub keyed to the shaft. A brass oil thrower protected the armature windings from any leakage of oil from the adjacent bearing. The commutator was built up of copper segments insulated from each other by mica and secured by a stepped design of end ring. The segments were mounted on a mild steel sleeve from which they were insulated by fibre bushes. The brushes, both for the exciter and the alternator current, were of brass wire, secured in holders of the pistol type weighted at one end to maintain the brush pressure.

The field magnets of the exciter were of solid cast iron, the field system being integral with the casting forming the exciter bracket, and carrying, at the same time, the inboard and outboard bearings. The same casting also provided the supports for the brush gear. The exciter field coils were wound on brass bobbins.

All the bearings of the machine were of the tubular sleeve type, lubricated from the ends under pressure. Reference to Fig. 37 will show that the cast iron bed-plate of the unit was hollow, and comprised two compartments. These formed part of the forced lubrication system, the lower compartment containing oil under pressure, which was forced up to the bearings through the pipes seen in the drawing. After passing through the bearings, the oil flowed to the upper compartment, and thence back to the lubricating pump.

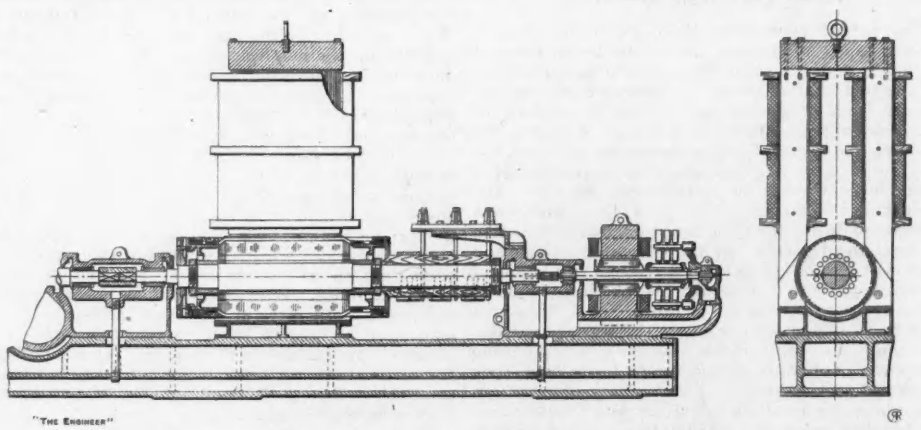


FIG. 37—SECTIONS THROUGH THREE-PHASE ALTERNATOR FOR ACKTON HALL COLLIERY

The Ackton Hall Colliery played a considerable part in connection with turbine development, both before and after the installation of the machine just referred to. As early as 1895 two direct-current turbo-generators, developing 150 kW each at 500 volts, were ordered from Messrs. Parsons, and a third similar set was installed in 1899. In 1901, in addition to the three-phase machine, a 300 kW, 500-volt direct-current turbo-generator was also installed. This was duplicated in 1909, and in 1918 a geared three-phase turbo-alternator of 1000 kW capacity at 3300 volts was added. The station then contained no less than eleven Parsons turbo-generators, of ages ranging up to twenty-two years, and exemplifying in a striking manner the application of the steam turbine to colliery purposes.

The Neptune Bank Turbo-Alternators.

The Neptune Bank power station was constructed in 1900 for the Newcastle-on-Tyne Electric Supply Company to inaugurate its supply of three-phase current at 6600 volts and 40 cycles. Its first three generating units were driven by triple-expansion, four-cylinder reciprocating engines of the marine type, which were regarded as the most efficient prime movers obtainable at the time they were ordered. The engines had cylinders of 21in., 31in., 34in., and 34in. diameter, respectively, the stroke of each being 3ft. The working steam pressure was 200 lb.,, the superheated steam temperature 480 deg. Fah., and the condenser vacuum 25in. to 26in. Hg. The engines ran at 100 revolutions per minute, and each unit developed 800 kilowatts at full load, the generators producing three-phase current at 6600 volts and 40 periods.

Very soon after the station commenced operation, additional plant became necessary, and the Company decided, no doubt in view of the excellent results obtained by the Parsons turbines at Elberfeld, to order a still larger unit from Messrs. C. A. Parsons and Co. This was a machine to develop 1500 kW at 1200 revolutions per minute, and it was put into service early in 1902. A longitudinal section through the turbine is reproduced in Fig. 38, which it is interesting to compare with the Elberfeld machine illustrated in Fig. 31 (*ante*). In spite of the greater power to be developed, it will be noted that the single-cylinder type was adopted. The design, moreover, shows notable advances. The balancing ports cast in the cylinder were eliminated, and with them a serious risk of distortion trouble. They were replaced by external pipes, not shown in the illustration, which connected each step in the drum diameter with the corresponding dummy piston. The whole of the bladed portion of the rotor, together with the dummy pistons, was formed from a single, hollow steel casting, machined inside and out, and supported from the shaft ends as shown. The coupling represented a decided advance in design, and was, indeed, the same in principle as the turbine couplings of to-day, and not unlike them in construction. The rotor was made in three diameters, increasing successively in the ratio $\sqrt{2}$ to 1, a practice which was followed in Parsons turbines for very many years. The blading was arranged in eight expansions which, with the increase of the diameter of the rotor, maintained the velocity ratio throughout the turbine reasonably constant in spite of the rapidly increasing volume of the steam. The blades of the high-pressure end were of brass, $\frac{3}{4}$in. long and $\frac{1}{4}$in wide, the final blades being 6in. long and $\frac{1}{4}$in. wide.

The emergency stop valve and the governor valve are illustrated in Fig. 39, the cover of the governor valve being shown in the drawing as if turned through 90 deg. in order to make clearer the arrangement of the starting lever. The spindle of the emergency valve was attached to a lever from the outer end of which was hung a heavy weight protected by a cylinder which served as a dashpot. The other end of the lever acted as a trigger. When the catch which held it was released, either by hand or by the action of the emergency governor in case of over-speed, the weight fell, causing the instantaneous closing of the emergency valve. The governor valve, like the emergency valve, was of the double-

beat type, and was kept in continual oscillation by the periodical admission of steam beneath the spring-loaded piston on the valve spindle. The motion of the valve was derived primarily from the worm-driven cross shaft which drove the two governors. At one end of this shaft was a crank which operated the lubricating pump, and a reciprocating motion was communicated by means of an inclined rod to a hinged bracket carried on the governor valve casing. This bracket was thus maintained in constant motion, and as it formed a kind of movable fulcrum for the lever operating the steam relay plunger, the latter was likewise kept in motion. If the speed of the turbine increased, the action of the governor was to raise the relay plunger, causing it to oscillate about a somewhat higher mean position, and thus to release more steam beneath the governor valve piston at each oscillation. The long horizontal lever which operated the relay plunger was attached near its outer end to a long helical spring, carried by a swan-necked pillar, which is seen best in the photograph of the machine reproduced as Fig. 43. By turning a regulating hand wheel, the position of the point of attachment of the lever could be raised or lowered, causing a corresponding lowering or raising of the mean position of the pilot valve, and, therefore, of the speed of the turbine.

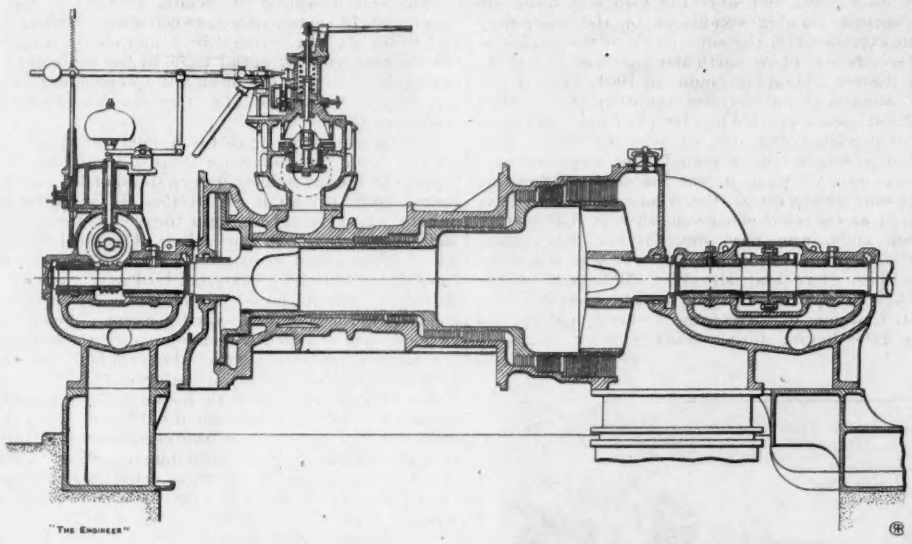


FIG. 38—SECTION THROUGH 1500 KW TURBINE FOR NEPTUNE BANK POWER STATION

When the Neptune Bank machine was supplied, it was coupled to an alternator of the revolving armature type, illustrated in Fig. 40, generating three-phase current at 6600 volts, 40 cycles, the speed of the set being 1200 revolutions per minute. The alternator gave trouble at the slip rings, whence the current was collected from the rotor, as leakage from one ring to another was difficult to prevent. The insulation of the armature also broke down where the coils crossed each other under the end caps. Single-phase alternators with revolving armatures did not suffer from this defect, as, in such machines, there was no crossing of the coils. It was also found afterwards that the tape insulation used in those days would not stand more than about 2 tons per square inch pressure without failure, and, therefore, could not resist the centrifugal forces.

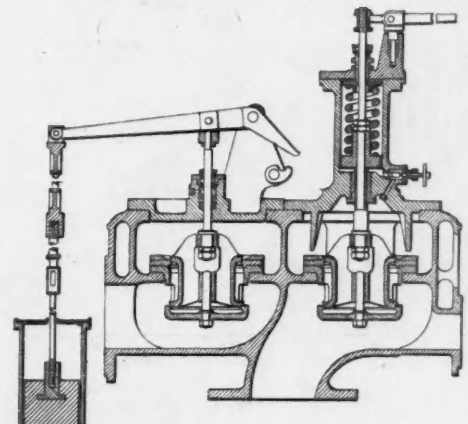


FIG. 39—EMERGENCY AND GOVERNOR VALVES

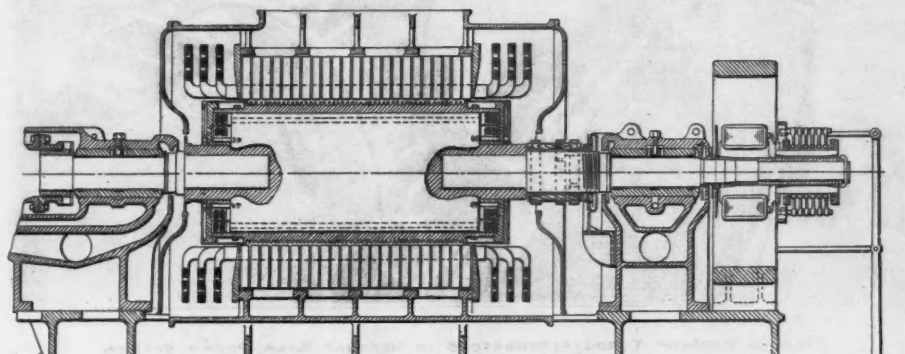


FIG. 41—SECOND ALTERNATOR FOR NEPTUNE BANK

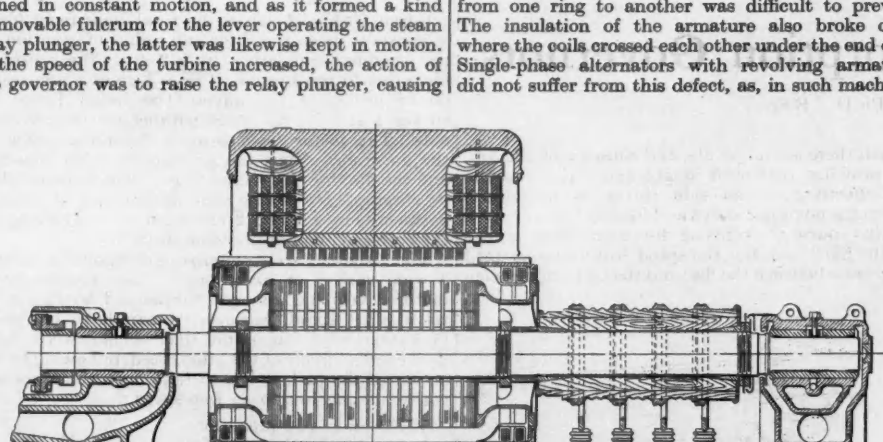


FIG. 40—THREE-PHASE 6600-VOLT ALTERNATOR FOR NEPTUNE BANK

On account of the difficulties referred to, it was soon decided to replace the original alternator with one designed on entirely new principles. In the new machine, illustrated in Figs. 41 and 42, the armature carrying the high-tension current is stationary, the field magnets being caused to revolve. This step marked a radical change in the design of turbo-alternators, and the principle then adopted has never since been abandoned. The form in which it was at first embodied, however, has been much improved. Reference to Fig. 42 will show that the rotor was constructed with four salient poles with clamps to hold the windings. The rotation of these poles was relied on to provide ventilation by stirring up the air inside the machine and causing sufficient draught to prevent overheating. The whole ventilating arrangements were somewhat primitive, for though there was an opening in the top of the stator for heated air to escape, the cool air had to get into the machine almost as best as it could. The turbine, with its improved alternator, was removed from Neptune Bank to the Carville power station, the construction of which was begun in 1903.

The salient pole type of rotor was never really satisfactory in high-speed machines. In alternators of the four-pole design, it was not too bad, but there were several serious accidents with two-pole rotors, for which a reasonably good mechanical construction was more difficult to obtain. The credit for the solution of the problem of rotor design must be given to the late Mr. Charles Brown, who designed the barrel type of rotor in universal use to-day. By their arrangements with Brown Boveri and Co., Ltd., who were manufacturing turbine machinery on the Continent under licence from C. A. Parsons and Co., Ltd., the latter firm was free to use the barrel-type rotor, and, therefore, adopted it on account of its obvious advantages. This, it is said, is the only instance in which any notable improvement in the design of high-speed electrical machinery has not originated at the Heaton Works.

The new barrel-type rotor was employed in a second unit of 1500 kW capacity supplied to the Neptune Bank station in 1903. Fig. 43 shows the two machines in the station. The turbine equipment of this station has a special interest, because, running alongside reciprocating engines of the latest marine type, it allowed a comparison to be made which had results of a far-reaching character.

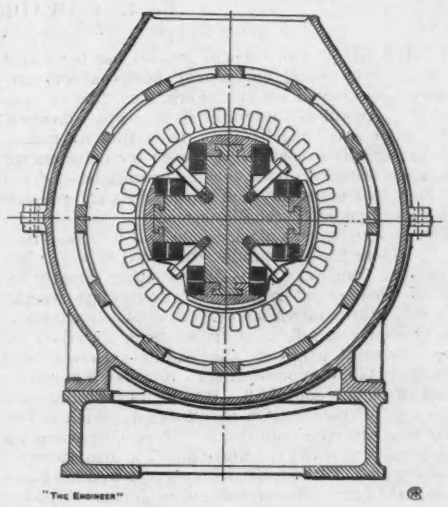


FIG. 42—END VIEW OF ALTERNATOR

Early in 1904 the Cunard Steamship Company appointed a commission comprising many of the leading marine engineers and shipbuilders in the country, to advise it with regard to the type of machinery to be fitted in the giant Transatlantic liners, the "Lusitania" and "Mauretania." Among its other investigations, the commission made

careful tests of the two types of prime mover at the Neptune Bank station. The results obtained are summarised in Table II.

TABLE II.—*Comparative Tests of Turbine and Reciprocating Machinery at the Neptune Bank Power Station.*

Test No.	Speed, r.p.m.	Average load, kW.	Steam pres. at stop valve, lb./in.²	Temp. at stop valve, deg. Fah.	Average vacuum, in.	Steam cons., lb./kWh.
Reciprocating Engine.						
1	100·8	798	203	482	23	24·22
2	87·9	589	204	476	24·25	23·48
3	74·5	316	201	457	25·6	23·42
4	52·5	96·5	204	425	24·5	30·93
Steam Turbine.						
1	1183	1478	203	453	25·9	18·67
2	1110	1092	204	448	26·7	19·65
3	903	600	203	440	26·8	24·01
4	649	196	212	436	27·7	35·01
5	1210	1822	203	480	25·5	17·80

It will be noticed that both engine and turbine were tested over wide ranges of speed, a condition by no means favourable to the turbine, which is essentially a constant-speed machine. When the turbine was running at full load and about its normal speed, its steam consumption was only about three-quarters that of the reciprocating engine, the difference being far greater than any advantage it might have had by reason of its greater power. At low loads and speeds, the reciprocating engine was the more economical, but since full load and speed are the normal running conditions of the machinery of an express liner, the superiority of the engine at low speeds was of no particular significance. Moreover, tests made on the engine in 1901, when it was new, showed a full-load consumption of less than 21 lb. of steam per kWh. Its efficiency, therefore, had depreciated with use, whereas the turbine had, within a fraction of a pound, the same full-load consumption as when it was installed. Taking all facts into consideration, the commission could have arrived at no other conclusion than it did, so that marine engineering owes much to the performance of the Neptune Bank turbines. It was stated by Mr. Chas. Merz and Mr. Wm. McLellan, at the Cambridge meeting of the British Association in 1904, that one of these same turbines had run for over 7500 hours, during which time it was only fifty-two hours out of commission for purposes of inspection.

(To be continued.)

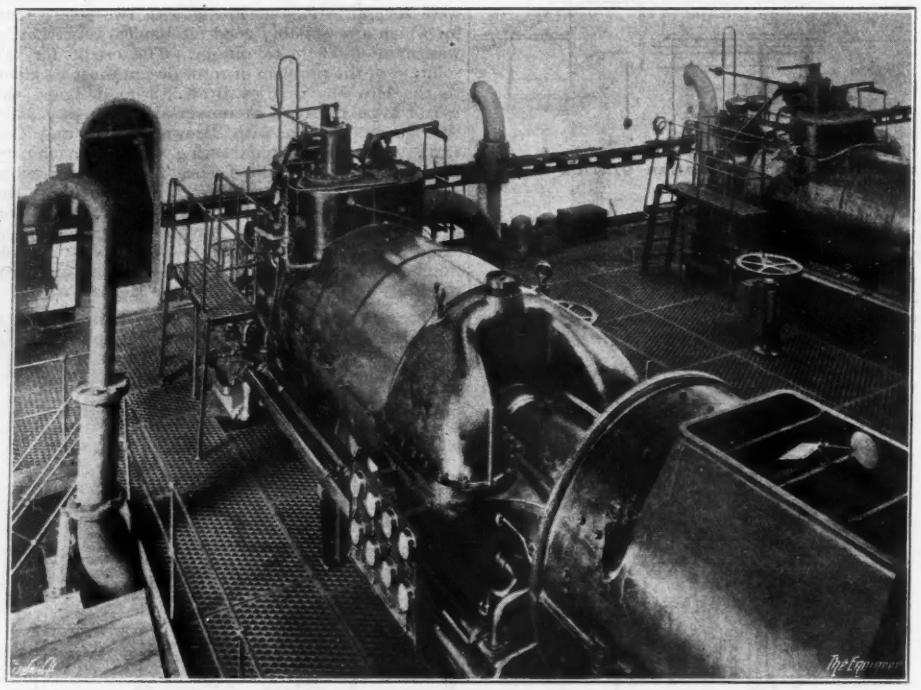


FIG. 43—PARSONS TURBO-ALTERNATORS IN NEPTUNE BANK POWER STATION

Centrifugal Power Absorption Governors.

By E. C. WADLOW, Ph.D., B.Sc.

ALTHOUGH it has been in general use for many years, the small centrifugal power absorption governor, employed on clockwork recording instruments, gramophone motors, stroboscopic devices, and similar small mechanisms, is, within its range, such an effective mechanical device for maintaining constancy of speed under varying conditions of drive and load that a discussion of some points in its design and performance may be of interest.

The lay-out of a typical design will be clear from Fig. 1. Here 1 is the spindle, the speed of which has to be kept constant. It is driven either directly by a motor element integral with it, or through gearing by a motor on another spindle conveniently situated. The governor spindle 2 is driven from spindle 1 by gearing—spiral gears in the example shown—and runs in suitable pivot bearings. A collar 3 is rigidly attached to the spindle 2. Round its periphery are three spring seats 4. On the sleeve 5, which is free to slide along the spindle, are three corresponding spring seats 6, while the brass disc 7 is also attached rigidly to it. Three springs 8, carrying weights 9, are anchored to the collar and sleeve as shown. A pad of leather or felt is carried by the arm 10, and is capable of being moved in a direction parallel to the governor axis and of being fixed in any desired position within certain limits.

When the spindle 1 is allowed to gather speed from rest the governor weights fly outwards under the action of centrifugal force against the controlling force exerted by the governor springs. These springs also act as links between the collar, the governor weights, and the movable sleeve. The design is one in which there are no pivots, and consequent friction. Also, provided that each weight and spring has the same effectiveness, no side thrust is introduced between the governor sleeve and its spindle.

In due course the rotating disc comes into contact with the fixed pad, but the speed still increases until the pressure between the disc and the pad reaches such

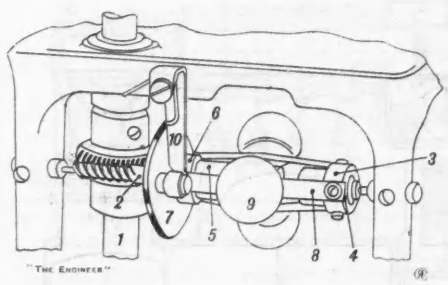


FIG. 1

a value that the energy dissipated here in friction, together with the other frictional losses, is equal to the output of the motor.

When the load is applied to the spindle 1 the device is no longer in equilibrium, and the speed falls slightly, the reduction occurring being that necessary to allow of a reduction in power dissipation at the governor disc equal to the load imposed at spindle 1. This statement neglects the friction losses occurring in the bearings and gearing.

The effectiveness of the device may be gauged from the following figures, representative of gramophone motor performance, where constancy of speed is very necessary. The torques developed by different designs and measured at spindle 1—Fig. 1—when running at 78 r.p.m., vary between about 0·35in.-lb. and 0·8in.-lb. In spring-driven motors the torque falls to zero from an initial value of the same order, but in electric types the mean value is constant on a time base, in the absence of voltage changes and other disturbing influences.

The torque which may be applied externally to spindle 1, or the change in driving torque at this spindle, to cause a reduction in its speed of 1 per cent., ranges from 0·05in.-lb. to 0·45in.-lb. in different designs. Low values of motor torque are not necessarily associated with low values of applied torque for a given speed reduction. Thus, if the motor torque is constant, the external load may vary from nothing to the full power of the motor, and produce a change in speed of little over 1 per cent. This is not as good as is obtained with more elaborate electrical governors; but, considering the simplicity of the mechanism, it is an excellent performance.

In a gramophone motor, for instance, the externally applied torque varies from about 0·16in.-lb. when the needle is in a groove near the periphery of a 12in. record to about 0·05in. when playing ceases. The speed changes caused by these variations in load should not exceed about 0·3 per cent., otherwise the changes in pitch of the music become audible.

The characteristics of a typical governor for the

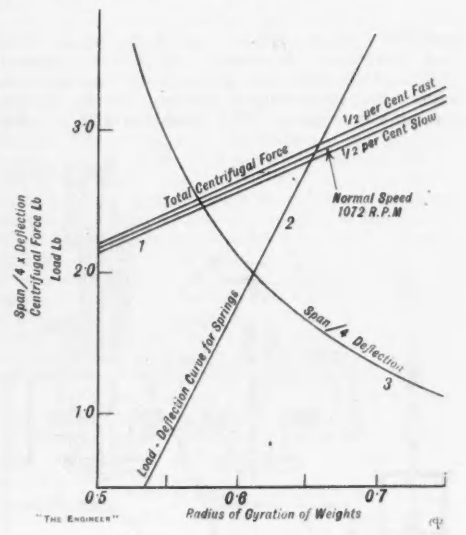


FIG. 2

above duty are set out in Fig. 2, the dimensions of the main details being :—

Mass of each ball	0·045 lb.
Spring section	0·190in. × 0·007in.
Spring span, in rest position	1·6in.
Angle of spring seats to axis	14 deg.

Curve 1—Fig. 2—gives the total centrifugal force at constant mean speed for any radius of gyration of the weights. Similarly, curve 2 gives the restoring force due to the springs. Curve 3 gives a numerical factor necessary to convert the radial forces of curves 1 and 2 into forces parallel to the governor axis. This factor depends upon the configuration of the governor. Thus the pressure between the pad and the disc for any radius of gyration of the weights is obtained by taking the appropriate difference between curves 1 and 2 and then multiplying it by the corresponding ordinate of curve 3.

Fig. 2 shows the characteristics of a governor under a wide variety of conditions. When coupled to a motor developing a steady torque and holding it to the desired speed, however, it can have one configuration only. This is not that which it would take up if running freely at the same speed, but owing to the action of the pad, it has to take up a configuration corresponding to a lower free speed.

If F = brake pad pressure,
n = rotational speed of governor,
T = torque measured at the governor spindle,
r = radius at which the pad acts,
μ = coefficient of friction between pad and disc,

k and c are constants for each value of n and radius of gyration of the weights, then

$$T = \mu r (k n^2 - c) \text{ and } \frac{d T}{d n} = 2 \mu r k n.$$

From these equations, and from curves such as those of Fig. 2, it is possible to determine the effect on the performance of such items as the following :—

(*a*) Coefficient of friction between governor disc and pad.
(*b*) Stiffness of friction pad material.
(*c*) Stiffness of governor springs.
(*d*) Mass of governor weights.
(*e*) Speed of rotation.

(*f*) Inclination of springs to axis at the point of anchorage.

(*g*) Length of springs.

Some of the conclusions may be stated without going into detail. Briefly, then, a stiff pad is desirable. Balanced pressures applied at opposite ends of a diameter, are preferable, as this arrangement eliminates side thrust between the sleeve and spindle. The advantage, however, is not marked, and the scheme is not often adopted because of the additional complication which results. To obtain a compact mechanism the coefficient of friction should be as high as possible, though, of course, the action must primarily be smooth and quiet, and the value constant over long periods. These conditions are best fulfilled by hard felt or leather rubbing on a lubricated brass disc.

Increasing the spring stiffness improves the regulation but makes the positioning of the pad more critical. Increasing the mass of the weights, on the other hand, improves the speed regulation and renders the positioning of the pad less critical. Increasing the speed enables a smaller governor to be used, but

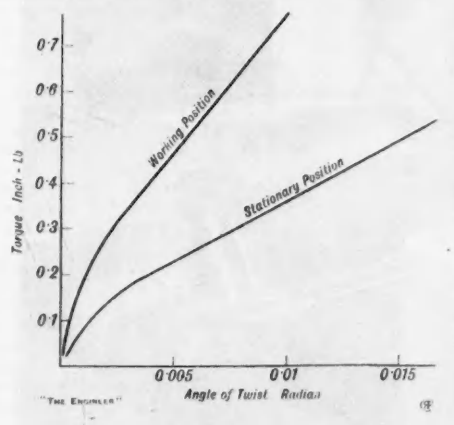


FIG. 3

introduces difficulties with the gearing. If spiral gears are used it is usually essential that the drive shall be reversible, and it is not always possible to ensure this if the ratio is higher than about 18 to 1. Spur gearing is used when the ratio is much lower and noise is not of great importance.

From a manufacturing point of view it is probably easiest to anchor the springs to seatings parallel to the axis, but better working results are obtained with an angle of inclination of between 10 deg. and 15 deg.

It will be evident that in a mechanism of this description, in which frictional damping is practically absent, a very small periodic exciting force may be sufficient to maintain a forced vibration of considerable amplitude. It is not uncommon for a governor of this type to commence oscillating in this way with no obvious external exciting force. Probably these oscillations occur when the coefficient of friction between pad and disc exceeds a certain critical value, for they can usually be stopped by lubricating

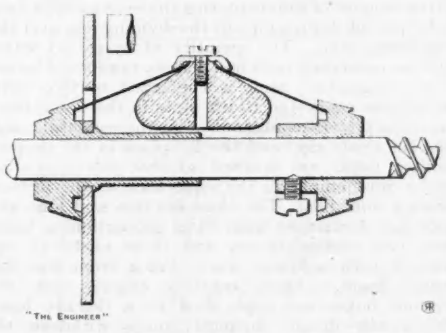


FIG. 4

both. This would reduce the coefficient of friction and make it more uniform during each revolution.

In calculating the natural frequency of the springs to transverse vibrations, the mass of the disc and sleeve must be taken into consideration. It has already been shown that the axial load on the disc is equal to a constant (from curve 3, Fig. 2) multiplied by (centrifugal force—controlling force). If W_2 is the weight of the sleeve and disc, then $\frac{W_2}{3}$ must be allotted to each spring. A mass of $\frac{W_2}{3}$ at the end of the spring in this manner is equivalent to a mass of $\frac{W_2}{3k}$ placed at the centre. If, also,

n = natural frequency of transverse oscillation, cycles per second,
E = Young's modulus for the spring material, pounds per square inch,
I = moment of inertia of spring section about its neutral axis, inch units,
L = length of spring between abutments, inches,
W = mass of governor ball, pounds,
W_1 = mass of one spring, pounds,

then the natural frequency of the system, when the ends of the springs are clamped in the usual manner, is given approximately by

$$n = 43 \cdot 3 \sqrt{\frac{E \cdot I}{L^3 \left(W + \frac{13}{35} W_1 + \frac{W_2}{3k} \right)}}$$

The value of k may vary from about 1·5 to 2 for a governor having the ends of the springs inclined to the axis at an angle of about 15 deg. This formula gives values which agree closely with actual measurements.

It will be observed that when there is no externally applied torque, the full torque of the motor is transmitted through the governor springs to the pad. The torsional rigidity of the governor is therefore of importance. The springs should always be fitted into narrow recesses or over suitable projections on both collar and sleeve with a view to increasing this torsional stiffness. There is also a possibility of

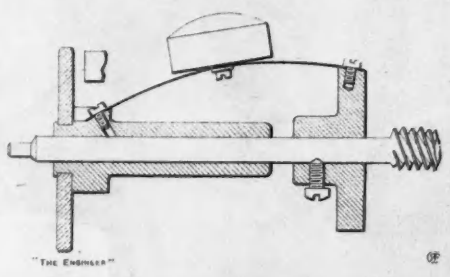


FIG. 5

torsional oscillations occurring, the natural frequency in this case being given by

$$n_1 = \frac{1}{2\pi} \sqrt{\frac{T}{I\theta}}$$

where

n_1 = natural frequency of torsional oscillations, cycles per sec.,
T = Torque, in.-lb., to produce a twist of θ radian,
I = moment of inertia of sprung mass about governor axis, inch and pound units.

Unlike the natural frequency of transverse oscillation, the natural frequency of torsional oscillation depends considerably upon the radius of gyration of the weights. This is because, as the weights move outwards, the stiffness T/θ increases more rapidly than I increases. The torsional stiffness in the working position is very much greater than in the position of rest, as shown in Fig. 3. The curves are taken from the design used in the preparation of Fig. 2. In this instance the natural frequencies of torsional oscillation corresponding with the rest and working positions respectively were approximately 65 and 88 per second. The natural frequency of transverse oscillation was 34 per second.

Various methods of preventing these unwanted oscillations have been suggested. Some include extra damping and are unsatisfactory because the speed regulating ability is then impaired. Other methods seek to lower or raise the natural frequencies out of the range of any likely periodic disturbing forces. In the Garrard governor, for instance, the natural frequency is lowered by reducing the spring stiffness. The three springs are simply hooked over suitably shaped abutments, as shown in Fig. 4, instead of being attached to the collar and sleeve by means of screws. When the weights are placed inside the springs, as in this design, they can be shaped so that excessive spring deflection—such as may occur if the governor oscillates violently—brings the springs into contact with the weights and thus introduces damping under favourable circumstances.

A method of raising the natural frequency of vibration and of increasing the torsional stiffness, without otherwise altering the performance, is to arrange the governor, as in Fig. 5, with the spring anchorages and the weights as far from the axis as possible.

The use of aluminium alloys for the sleeve and disc offers a means of reducing weight if the natural frequency is to be increased, but the wearing properties of these materials are inferior to those of brass and they are very rarely used.

All these devices have their value, but a simple course to adopt is that of keeping the governor pad well lubricated. In fact, for anything approaching continuous operation constant lubrication is essential. It also assists in reducing wear of the disc, which will always give unsatisfactory running.

The springs may be subject to considerable lateral and torsional strains, and it is necessary to use a good quality hardened and tempered steel strip. Material having a Vickers diamond pyramid hardness numeral of about 550 to 600 is found to be suitable. The holes in the springs, for attachment to the weight and to the anchorages, are punched out of the hard strip for small governors such as are at present being considered. As the sectional area is considerably reduced where perforations are made, fairly large washers should be used beneath screw and rivet heads to prevent the greatest stresses occurring at the weakest places.

The governors already described are designed to operate effectively over a comparatively narrow speed range. If the speed is below this the efficiency is seriously impaired, as the change in centrifugal force for a given speed change is reduced. On the other hand, if the speed is much above the normal range, twisted and broken springs may result, particularly if the higher speed is accompanied by a higher motor torque.

In the Paillard two-speed governor, introduced just over a year ago, the controlling force is varied by having an auxiliary helical spring, which becomes operative only at the higher speed. In this design, shown in Fig. 6, the shaft is of two diameters, and a

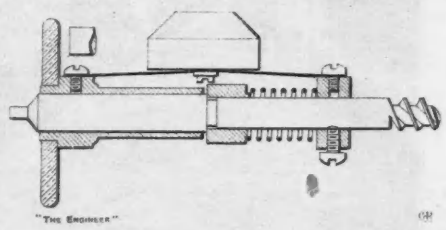


FIG. 6

sliding collar is held against the shoulder so formed by a helical spring, the other end of which abuts against the normal fixed collar. At the lower operating speed the pad limits the motion of the disc and sleeve, and the only controlling force is that exerted by the three flat springs which carry the weights. On moving the governor pad back, to allow the speed to increase, the sleeve comes into contact with the sliding collar and the helical spring now assists the flat springs. In this way the springs can be proportioned to give the same governor performance at any two given speeds.

It may be pointed out that the torsional stiffness of this governor is determined by the dimensions of the flat springs, the helical spring having no influence even at the higher speed, and therefore due consideration must be given to the torque-speed characteristics of the motor with which the governor is to be used, if spring trouble is to be avoided.

All the governors so far considered follow the same general arrangement. One of the very few unorthodox

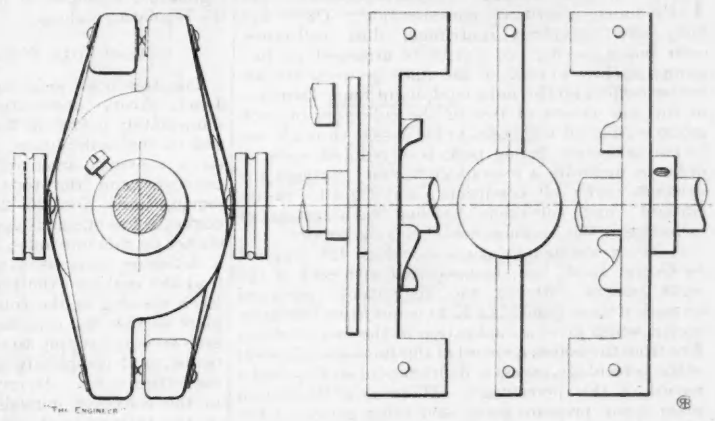


FIG. 7

lay-outs at present being manufactured is shown in Fig. 7, this design being used in the American "Green Flyer" motor. One of the mouldings is fixed to the shaft while the other rotates relatively to it as the weights move outwards. This relative rotational movement between them also causes axial separation, owing to the movement which occurs between interacting inclined projections on both parts, and the pad operates against the disc in the usual way. The lay-out gives a governor having a very short axial length, but the performance of a good example of the orthodox form is better. The ends of the springs are not clamped tightly against the mouldings by the rivets, and thus the springs are not twisted as the two parts separate. The friction between the two sets of inclined planes is an undesirable feature.

In the search for improved performance and lower manufacturing cost numerous other alternative designs have been produced from time to time, but they have so far failed to supplant what may be regarded as the standard form.

THE NEW BARKING POWER STATION

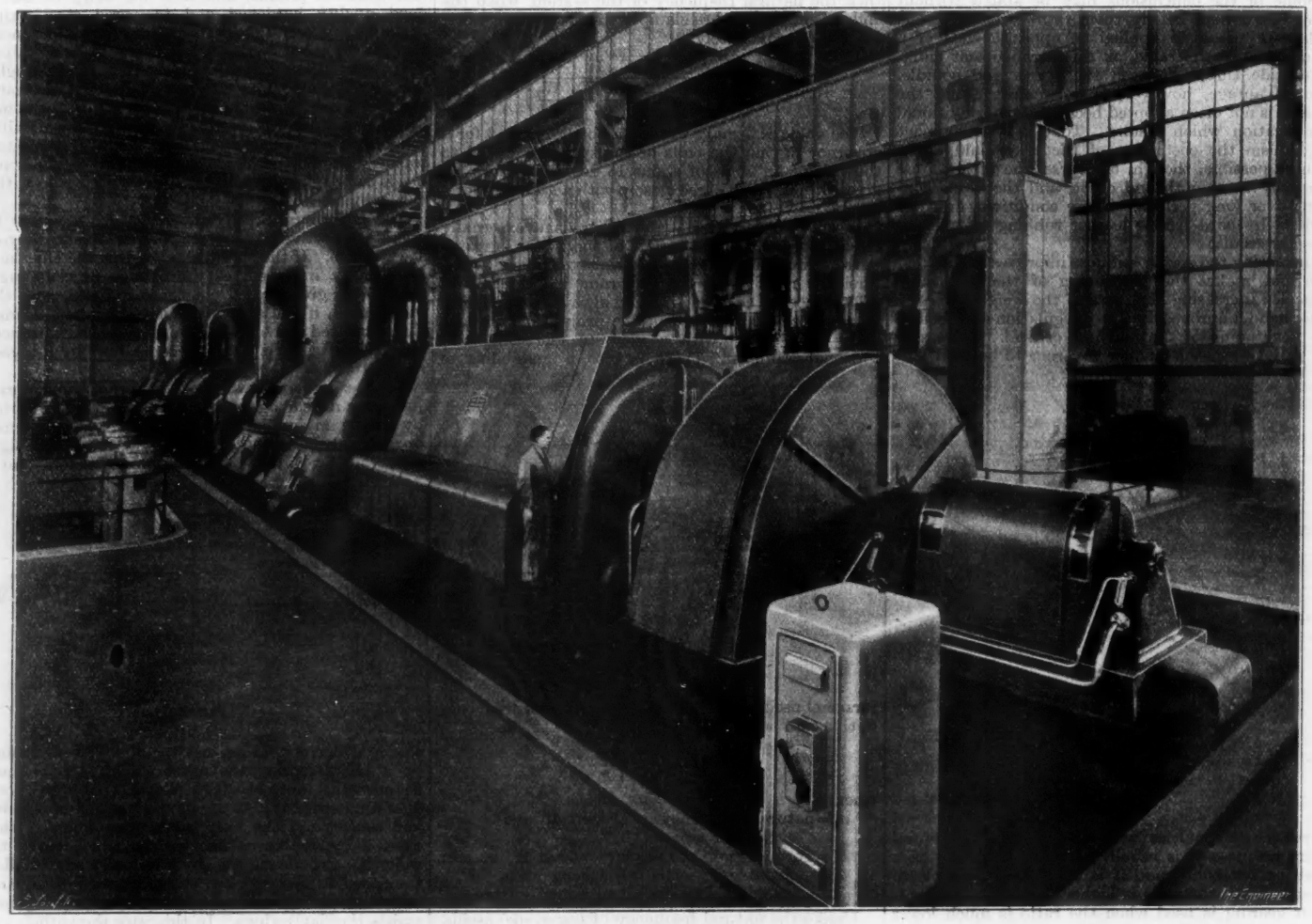


FIG. 11—75,000-KW TURBO-GENERATORS

The New Barking Power Station.

No. II.

(*Continued from page* 121, *February 2nd.*)

THE new steam-raising equipment does not call for much additional consideration. There are forty-eight Davidson centrifugal dust collectors, each boiler having six collectors arranged in two groups of three in each of the flues between the air heater outlet and the induced draught fans. Dampers in the gas outlets of two of the collectors of each group enable all the gases to be passed through one or two collectors during periods of reduced loads, in order to maintain a reasonable velocity through the cyclones under all conditions, and thus to ensure efficient dust collection. Below each group of collectors is the common dust-receiving hopper.

A boiler instrument panel (see Fig. 12) supplied by George Kent, Ltd., is associated with each of the eight boilers. Among the instruments mounted on each of these panels is a Kent combustion efficiency meter, which gives an indication of the rate of steam flow from the boiler, a record of this flow, an indication of the percentage, excess or deficiency, of air flow, and a record of this percentage. There is a Hopkinson main steam pressure gauge and other gauges of the same make for giving superheater and economiser pressures, a Negretti and Zambra multi-point electrical thermometer for giving gas and water temperatures on the economiser, and air temperatures on the air heater; four Negretti and Zambra mercury-in-steel dial-indicating thermometers, for showing superheater steam temperatures and gas temperatures on the air heater; a Negretti and Zambra multi-point draught gauge; a Ranarex CO_2 indicator and recorder showing the percentage CO_2 at various points; a Radiovisor smoke detector, and a dial thermometer giving the temperature on the transformer supplying the boiler auxiliaries. Controls are also provided for the six fans, hydraulic couplings, and dampers. Each boiler has two gauge glasses, one of which is used in conjunction with a Parsons projector periscope, which enables the water level to be read with ease at the firing floor level. Three types of soot blowers are fitted to the boilers—a Babcock Clyde single-nozzle blower, a Babcock single-nozzle blower, both operated at 200 lb. per square inch, and a Babcock Diamond multi-jet blower, operating at 100 lb. per square inch. On each steam-raising unit there are two Copes 4in. water regulators, arranged in parallel to limit the size of the regulating valves.

TEST COAL WEIGHING EQUIPMENT.

The test coal weighing equipment consists of a 4 cwt. Avery automatic coal weigher, arranged immediately below the test coal bunker at the south end of the boiler-house, together with a horizontal screw conveyor arranged between the outlet of the conveyor and the tops of the traversing chutes serving units Nos. 25, 26, 29, and 30. The screw conveyor has openings opposite each of the traversing chutes on the four units, and a bifurcated chute with a deflector valve is fitted below each opening to lead the coal into the tops of the traversing chutes. Each opening in the conveyor is fitted with a slide plate so that the coal discharge can be regulated to give an equal supply to each chute of the unit being tested, and completely shut off from the chutes of the other units. An overflow opening is provided in the conveyor immediately beyond the openings of the traversing chutes, so that any coal carried beyond the openings of the chutes is deposited in the nearest stoker hopper of the unit being tested.

WATER-SOFTENING PLANT.

The make-up water is obtained from the South Essex Water Company, and owing to its hardness a water-softening plant has been installed by the Kennicott Water Softener Company, Ltd. As the water varies considerably in composition, the Kennicott patented proportioning gear, which only necessitates the adjustment of a handle on the dividing box feeding the water to the regulating tank in order to adjust the quantity of chemicals supplied to the softener, is fitted. A Hatfield automatic testing apparatus continuously records the hardness of the hard and softened water, and the proportioning gear is set according to its readings. Tests on both the hard and softened water are also made in the station laboratory in order to check the Hatfield apparatus readings. Water from the mains enters the head tank supported at the top of the main reaction tank, as shown in Fig. 13, and the main quantity of water from this tank passes through an adjustable slot and down a chute into the central downtake in which there is a paddle driven by a motor.

The chemicals which are pumped from the proportioning gear at ground level also enter this downtake, and as they pass into it they are intimately mixed with the water by the agitator. The treated waterflows by way of the downtake to the bottom of the reaction tank, when it reverses its direction and flows upwards at a very slow rate, and is finally filtered at the top of the reaction tank by a wood wool filter packed between two rows of perforated filter plates. For the purpose of proportioning the chemicals, a small quantity of hard water, which is in direct proportion to the amount of water entering the reaction chamber, is by-passed down a pipe to the dividing box over the regulating tank. The quantity of by-passed water fills the regulating tank in a definite number of hours.

The regulating tank is connected to two wells with floats connected to lift pipes in the alum, lime, and soda proportioning tanks. As the regulating tank fills the floats rise, and the lift-pipes in the proportioning tanks are lowered so that the regulating tanks must empty in the same time as the proportioning tank fills. The alum solution and lime and soda are discharged from these proportioning tanks into two suction boxes, and these chemicals are diluted with softened water taken from the soft water main. Float controls ensure that the suction boxes are kept filled to a definite level. Electrically driven chemical pumps withdraw the chemicals from the suction boxes and discharge them into the downtake at the top of the reaction chamber. The proportioning gear is in duplicate, and one gear is in operation while the other is standing. The mixing tanks for the alum solution on the floor above the proportioning tanks are always kept filled with the correct alum charge, so that when the proportioning tanks are empty a new charge can be run through by gravity.

On the floor above the proportioning tanks the hydrated lime and soda charges are also weighed, and the mixed charge of soda and lime is discharged directly into the proportioning tank below by means of chutes. The plant is entirely automatic. When water from the softening plant is no longer required, the reaction tank gradually fills up and a float connected to the main equilibrium float valve rises and shuts off the water. At the same time another float comes into operation and throws out the switch associated with the motors driving the chemical pumps, thus automatically shutting off the supply of chemicals to the softener. The sludge produced in the softening process is deposited at the bottom of the main reaction tank, and is removed at intervals by means of Kennicott patented revolving sludge gear. When

it is necessary to sludge the softener the main sludge valve is opened and the horizontal arms are made to rotate by means of a shaft driven by a handwheel. As the arms rotate, the head of the water in the reaction tank forces the sludge through slots on the revolving arms and out through the main sludge pipe into the sump. The capacity of the plant is 360,000 gallons per day, and the period of reaction six hours.

TURBINES.

The two 75,000-kW generating sets were built to the order of Messrs. Merz and McLellan, the consulting engineers, partly in the Rugby works of the B.T.H. Company and partly in the Trafford Park works of the Metropolitan-Vickers Electrical Company. The normal pressure at the stop valve is 600 lb. per square inch gauge and the maximum 700 lb. per square inch. Normally the steam is superheated to 800 deg. Fah. at the turbine stop valve, but the temperature may rise to 850 deg. Steam is bled under normal conditions from four points of the turbine casing to heat the water of condensation up to 340 deg. Fah. at a load of 60,000 kW. When the turbines are running at this economical output, the normal vacuum in the condensers is equivalent to 1in. of mercury absolute. The turbines (Fig. 11) have three cylinders. The high-pressure cylinder, composed of steel throughout with the top and bottom sections, each composed of a single casting, contains a two-row velocity compounded stage and nineteen low velocity impulse stages. Full belt admission to the inlet nozzles of the first stage is under the control of two governor valves, one in each of the two steam chests, mounted on either side of the high-pressure cylinder, and these valves deal with loads up to 45,000 kW. Two additional governor valves, also each arranged in the two steam chests, serve to by-pass the first stage wheel for obtaining loads above 45,000 kW to 60,000 kW, and four additional governor valves arranged two in each of the two steam chests, serve to by-pass the first eleven stages for obtaining loads above 60,000 kW up to the maximum continuous rating. All the connections between the steam chests and the cylinder are below floor level and are of " U " shape to provide the necessary flexibility.

As the construction details of these machines correspond in many respects with those of the Battersea machines, described in our issue of June 2nd, 1933, we need not refer to them fully. The built-up diaphragms in the high-pressure cylinder consist of steel plate centres with independently machined nickel steel nozzles fitted and riveted to them. The moving blades are of rolled section stainless steel, with separate packers both with T-shaped roots, which fit into corresponding grooves machined in the disc peripheries. At the inlet end and on the balance piston the main glands are of the double comb radial clearance type, while that at the outlet end is of the single comb radial clearance labyrinth type. These comb glands are supplemented by water seal glands to prevent discharge of leakage steam into the turbine-room. An adjustable Michell thrust bearing at the high-pressure end allows the clearance to be modified while the set is stationary or running, and an external scale shows the extent of clearance provided.

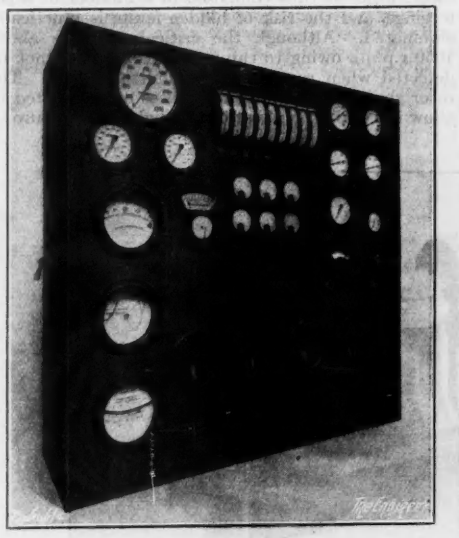


FIG. 12—BOILER INSTRUMENT PANEL

Except for the exhaust end, which is composed of cast iron, the intermediate pressure cylinder is also made of steel. The diaphragm and moving blade construction for the earlier stages is similar to that of the high-pressure cylinder, but the five final stages have cast iron diaphragms with rustless steel cast-in blades, the corresponding moving blades of these stages being of the straddle type riveted to the discs. The glands at the two ends of the cylinder are of the same type as those described and are supplemented with water seal glands. In this cylinder there are twenty impulse stages and the rotor is located by a Michell thrust bearing at the inlet end. A Bibby flexible coupling unites the high and intermediate pressure rotors.

The double-flow, low-pressure cylinder and rotor are shown on page 150. The cast iron cylinder is divided into six portions to facilitate handling and transport. At each end of the cylinder there are four cast iron diaphragms with carbon steel nozzle plates cast into them. The split diaphragms have a keyed joint, which limits the amount of leakage steam from one stage to the succeeding stage to a minimum. Segmental labyrinth packing in the central opening of the diaphragms through which the shaft passes is composed of a nickel-bronze alloy, and the segments are held against the diaphragms by means of leaf springs. Four wheels are pressed on to the rotor shaft on either side of the vertical line. Stainless steel moving blades, machined out of rectangular section, are used in all the stages. At each end of the casing water seal glands are provided, each consisting of a paddle wheel with curved vanes rotating in an annular chamber fed with condensate from a tank placed at a suitable height.

Particular care has been taken in this cylinder to drain away as far as possible the condensed water in the steam during its passage through the cylinder. The water of condensation is thrown outwards from the rotating blades into an annular chamber formed on the periphery of each diaphragm and is discharged into space at a lower pressure than that existing in the stage. A Michell thrust bearing incorporated in the main bearing adjacent to the intermediate cylinder fixes the axial position of the shaft, which is connected to the intermediate pressure shaft by a Wellman Bibby coupling, the other end of the low-pressure shaft being connected to the alternator rotor by means of a semi-flexible coupling. Any change of the rotor position is instantly indicated by a pointer fixed in the bearing cap above the flexible coupling.

In the steam chests which control the admission of steam to the high-pressure cylinder nozzle valves by means of the governor valves mentioned there are emergency and stop valves. Each chest has, in addition to the governor valves, one emergency and one stop valve, which are held in the open position by means of oil under pressure supplied by the main positive displacement geared lubricating pump. In the event of overspeed the ring type emergency governor trips the valve controlling the supply of oil to the operating cylinders of the emergency valves, which are closed under the action of spring loading and steam pressure.

As an additional precaution the governor valves controlling the admission of steam to the high-cylinder are also closed. Similarly, failure of the lubricating oil causes these valves to close auto-

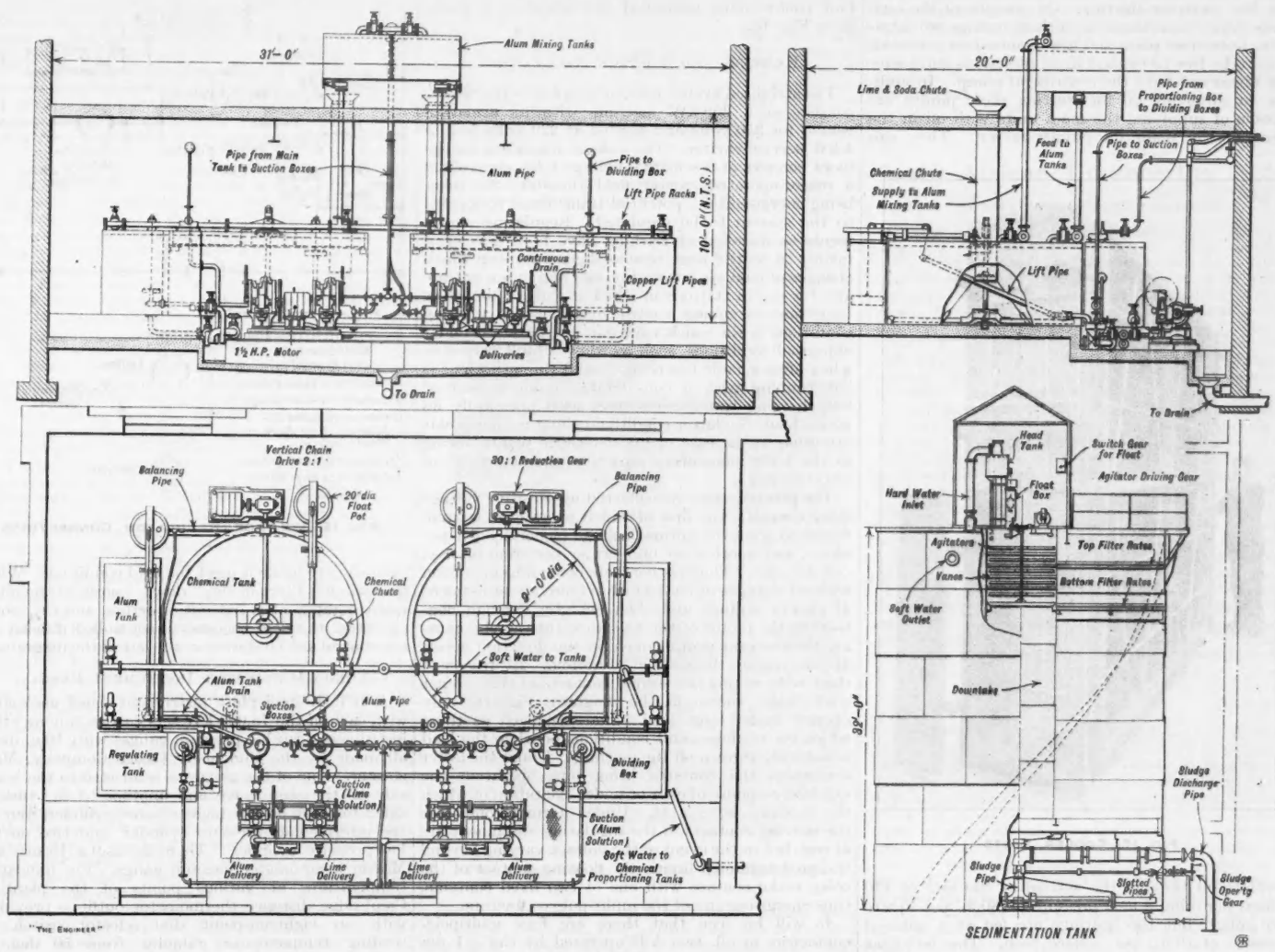


FIG. 13—GENERAL ARRANGEMENT OF WATER-SOFTENING PLANT

matically. The main spring-loaded governor controls the position of two pilot valves which individually allow oil to flow to or from the servo-motor cylinders which rotate cams controlling the opening or closing of the steam admission valves associated with the high-pressure cylinder. A cylindrical servo-motor with rotating vane is fixed to each steam chest and the oil pressure difference across the vane causes the vane to rotate and to turn a shaft carrying cams which engage with levers and so open or close the steam admission valves. The No. 1 valves in the two steam chests open simultaneously and are followed simultaneously by valves Nos. 2, 3 and 4 operating in pairs in each steam chest. After any adjustment of the valves brought about by change of load the pilot valves are returned to the "neutral" position. Means are provided for limiting by hand the maximum valve opening on each steam chest so that the load on the unit can be predetermined and cannot be exceeded.

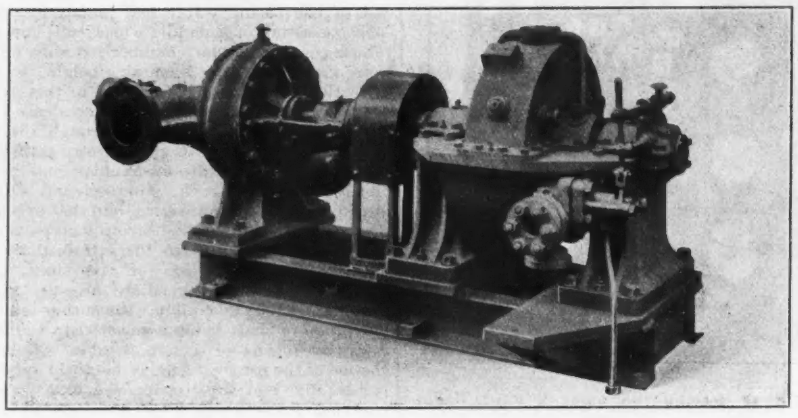


FIG. 14—OIL PUMP

Horizontal turbine-driven centrifugal oil pumps—Fig. 14—serve for starting. On account of the high temperature conditions the turbine casings are fabricated from steel plate and are mounted on pedestals so as to be free to expand in all directions and maintain alignment with the centrifugal pump. In addition to supplying oil for starting these pumps are capable of supplying the main units with oil in the event of the main oil pumps failing. They can circulate oil through the system at the rate of 410 gallons per minute at a pressure of 80 lb. per square inch gauge, but the bearings are fed at a reduced pressure of 10 lb. per square inch. The fact that over one and a-half tons of oil are circulated per minute gives an idea of the dimensions of these pumping units. Auto-Klean strainers are provided for continuously filtering the oil.

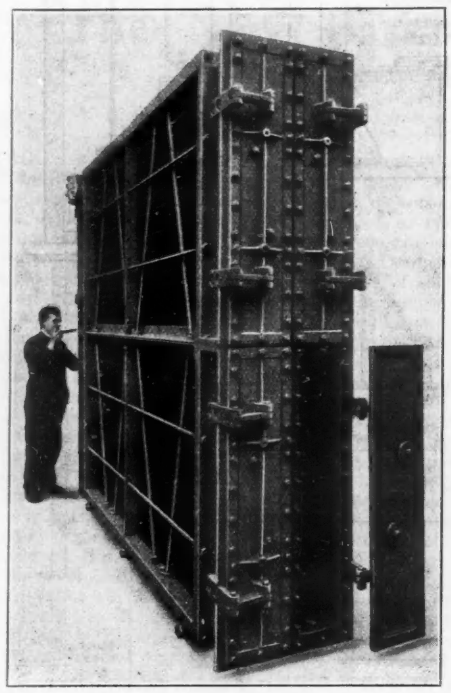


FIG. 15—COOLER UNITS

ALTERNATORS.

Both the alternators are rated at 93,750 kVA at 0·8 lagging power factor, but are capable, in addition, of carrying a wattless leading current corresponding to 25,000 kVA. The weights of the component parts are:—Stator, 150 tons; rotor, 72 tons; blower, 12 tons; and exciters, 10 tons. The stator frame is fabricated, and in order to minimise eddy currents generated by leakage flux from the rotor and stator end windings an aluminium sheet is rolled over the outside face of the flange at each end of the stator core, which is composed of punchings from a new high-silicon steel said to show a marked improvement in efficiency. The stator is wound for 12,500 volts. Plates shrunk on to the shaft form the alternator rotor, which is thus composed of a number of small forgings, and the risk of hidden faults is practically eliminated. Although the critical speed is about 1050 r.p.m., owing to careful balancing it cannot be detected when running up or shutting down. The rotor shaft is fluted and the plates are separated to allow internal air circulation through the structure.

A radial impeller type blower with a capacity of 100,000 cubic feet of air per minute is coupled to the end of the alternator shaft and serves to ventilate the complete machine; the air being carried to and fro between the alternator and blower by means of passages formed in the foundation. Each machine has four cooler units assembled and installed in pairs, as in Fig. 15.

EXCITERS AND VOLTAGE REGULATORS.

The stabilised exciter directly coupled to the blower consists of a 200-kW machine with its armature wound for 350 volts and excited at 220 volts from a 4-kW service exciter. The voltage regulating equipment consists of a sensitive voltage relay controlling a motor-operated exciter field rheostat, the relay being energised by a potential transformer connected to the system to be regulated. Regulating equipments as installed at Barking have been developed mainly to control large base load generators on which changes of load are infrequent, and of a minor nature, and for use in stations in which a feature almost as important as voltage control under normal working conditions is the quick variation of excitation under abnormal conditions, such as when a fault occurs or when after a fault has been cleared the generator is left running with a considerably reduced load or left charging transmission lines with practically no power load, the latter condition calling for particular attention in the case of hydro-electric plants, owing to the wide momentary variation characteristics of water turbines.

The primary control is effected by sensitive voltage relay contacts, the first of which operate on a small variation from the normal voltage (generally ± 1 per cent.), and another set on a wider variation of, say, ± 5 per cent. The first contacts come into operation with all changes of load which require an adjustment of exciter voltage and then energise through contactors, the motor of the field rheostat thereby causing the rheostat arm to move in the direction necessary to restore the voltage to normal. By reason of their wide setting the second contacts of the ± 5 per cent. relay, shown in the diagram, Fig. 16, only operate under large load variations, such as those which occur under fault conditions or when the load is suddenly thrown off the machine. Under the latter conditions the contacts bring into operation the quickest response of over or under excitation of which the machine is capable. Under normal conditions the moving contacts of the regulating equipment are at rest, but in the event of the voltage varying beyond the predetermined limits, the floating contact of the relay make contact with one of two fixed contacts, thus energising one of the multi-pole contactors.

It will be seen that there are four multipole-contactors in all, two A B operated by the ± 1 per cent. contacts and two X Y by the ± 5 per cent. contacts. These multi-pole contactors generally have four poles, and it will suffice to consider mainly those associated with contactors A and B. With a small change of voltage produced by a variation of the load, the ± 1 per cent. relay operates and energises the appropriate contactor and the first set of contacts of this contactor A_2 or B_2 operates across a small resistance in series with the operating coil of the relay, thus causing the relay to reopen its contacts and so de-energises the contactor, if the change in voltage is not more than, say, 2 per cent. This gives an impulse action to the relay and contactor. The second set of contactor contacts B_1 or A_1, which energise the rheostat motor, causes the rheostat arm to move one step at a time. The motor operating the field rheostat has two oppositely connected field windings, so that the direction in which it turns is determined by whether contact A_1 or B_1 is closed. The third set of contacts B_3 or A_3 operates across a small portion of the exciter field rheostat in order to overcome the electro-magnetic inertia of the alternator and exciter field systems; whilst the last set of contacts B_4 or A_4 inserts resistance in series with the contactor operating coil, thus ensuring that the contactor will open promptly when the voltage relay opens and incidentally relieves the contact of a considerable amount of breaking duty.

The impulse action of the relay continues until the voltage is restored to normal, when the relay floats between the two fixed contacts and for a change of voltage of ± 1 per cent. the action of the regulator is practically dead beat.

Under severe voltage variations the ± 5 per cent. contacts bring one of the multi-pole contactors X or Y into operation. If the voltage variation is not more than, say, 7 per cent., one set of contactor contacts produces an impulse action as described. The second set of contacts speeds up the rheostat motor, so as to make the adjustment as quickly as possible. The third set short-circuits or inserts the whole of the field rheostat, thus rapidly altering the excitation to make it meet the load conditions. When the switches C are in the "down" position the automatic equipment is put out of action, and the motor operating the field rheostat is controlled directly by the control switch shown on the left of the diagram.

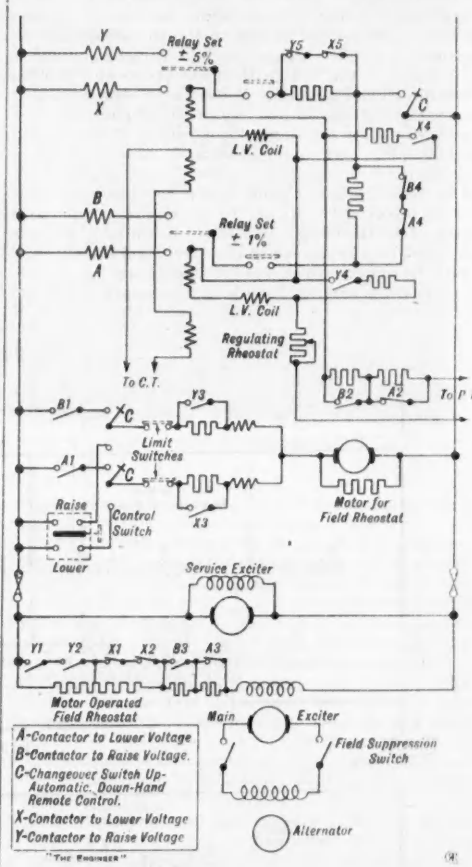


FIG. 16—VOLTAGE REGULATOR CONNECTIONS

TURBO-ALTERNATOR INSTRUMENT PANELS.

A B.T.H. steel plate instrument panel associated with each of the 75,000 kW sets carries, among other instruments, twelve pressure gauges with 10in. dials, all made by the Budenberg Gauge Company, Manchester. One of the gauges is connected to the boiler side of the stop valve and another to the turbine side; four are on the high-pressure cylinder, four on the intermediate-pressure cylinder, and two on the low-pressure cylinder. There is also a Brady and Martin kenotometer vacuum gauge. For indicating temperatures at various points of the plant, a Cambridge distance thermometer outfit is provided, with an eighteen-point dial selector switch for reading temperatures ranging from 50 deg. to 1000 deg. Fah. The resistance type thermometesr are located at the following points:—Steam inlet to H.P. turbine; steam outlet from H.P. turbine; steam inlet to L.P. turbine; steam outlet from L.P. turbine; condensate water inlet to gland heater; condensate water outlet from gland heater; condensate water outlet from L.P. heater; condensate water outlet from drain cooler; feed water outlet from intermediate-pressure heater; feed water outlet from evaporator heater; feed water outlet from high-pressure heater; crude water inlet to crude water heater; crude water outlet from crude

water heater. A similar distance thermometer outfit gives temperature indications on the condensing plant. Each panel also carries a Siemens engine-room telegraph indicator.

Indications on the temperatures of the alternator end are given on two Cambridge instruments on the switch panels in the control room.

HOUSE SERVICE SET.

The B.T.H. house service set is rated at 3500 kW (M.C.R.), when exhausting into a 29in. vacuum, or when working against a back pressure of 5 lb. per square inch gauge. The turbine is capable of running under the maximum steam conditions, *i.e.*, 700 lb. per square inch gauge and 850 deg. Fah. In the event of trouble the set can be started up automatically from the control room. To meet this condition, the turbine stop valve is motor-operated, and when a push-button is pressed in the control room, the motor opens the valve. When started in this way, with all the auxiliary power cut off, the set exhausts to atmosphere until a condensing circulating pump starts, and the sluice valve between the turbine and condenser is opened. In view of the severe starting conditions that may be imposed, the design of the machine is somewhat special. The entire casing is made of cast steel and the seven rotor wheels are exceptionally stiff. Where they fit on to the shaft they are provided with radial pin bushings. As the set will run up to speed in approximately 1½ min. from cold, there are large temperature differences between the wheels and shaft, and the radial pin bushings permit of differential expansion without the wheels becoming slack or running excentrically. The control gear is of the normal B.T.H. nozzle type. The alternator is also of standard construction with a stabilised exciter.

(To be continued.)

The Sperry-Villiers Odograph.

IN our issue of October 6th, 1933, we illustrated and briefly described the Sperry-Villiers odograph, an instrument made by the Sperry Gyroscope Company, Ltd., and designed to record to scale on a chart the actual course followed by a ship at sea. The pattern which we illustrated on that occasion represented the original form of the instrument, but in our accompanying notes we mentioned that an improved form, differing from the original in some important details, had recently been produced. We are now in a position to describe this improved form in greater detail than was possible on the previous occasion.

The general principle of the instrument makes use of a dual movement of a wheel which is free to set itself at any point on the surface of the chart. The first movement of this wheel is a rotation about its axle. This axle is arranged horizontally—or, more precisely, parallel with the chart surface—and the wheel is rotated about it by impulses received from an electrical ship's log. The impulses are received at intervals which increase as the ship's speed diminishes and shorten as the ship's speed rises. The intervals are, however, sufficiently short in all cases to ensure a practically continuous rotation of the wheel at a speed which, in effect, is proportional to the ship's speed.

The second movement of the wheel consists of its rotation about a vertical diametral axis—or, more precisely, about a diametral axis at right angles to the chart surface—and is imparted to it by impulses received from the ship's gyro-compass or from the repeater transmission system commonly installed to work in conjunction with the master gyro-compass. The requirement to be fulfilled in connection with this second rotation can best be made clear by a diagram such as that given in Fig. 1. At A a ship is represented sailing due north and with the north and south direction of the chart aligned parallel with her longitudinal centre line. In these conditions the plane of the wheel should be parallel with the ship's longitudinal central plane, in order that the rotation of the wheel on its axle, by the impulses received from the electrical log, may result in a line being drawn on the chart towards the north of the chart. At B the ship is represented after her course has been altered through θ degrees to the west. The chart partakes of this movement, and therefore in order that the new course may be correctly drawn on the chart, the wheel must turn about its diametral vertical axis until its plane is lying at an angle θ relatively to the ship's longitudinal central plane. In other words, the requirement is that the wheel should be controlled to set its plane, relatively to the ship's longitudinal central plane, at the same angle as the direction of the ship's course bears relatively to the true north. It will be observed that this requirement necessitates a rotation of the plane of the wheel through an angle of 2θ relatively to the true north for an alteration of θ degrees in the ship's course. This is the total or absolute movement of the plane of the wheel. The actual movement to be imparted to the wheel is one of θ degrees relatively to the ship. This movement can readily be given to it by coupling it up to the gyro-compass system. As the ship turns through θ degrees to the west, the directional line of the gyro-compass remains pointing to the north. The ship, in effect, swings beneath the compass and thereby generates the angle N O L. This angle is transferred by the connecting mechanism and is reproduced as the angle L X P, through which the plane of the wheel is turned relatively to the ship's longitudinal central plane.

It should be noted that in the diagram the chart is represented with its north and south direction parallel with the ship's longitudinal centre line. It may, however, be set in any other alignment relatively to the ship, provided this alignment once set is not altered during the voyage without a compensating adjustment being made. At the outset of the voyage the plane of the wheel is set by hand to agree on the chart with the direction in which the ship's head is momentarily pointing, that direction being obtained from a reading of the gyro-compass. Thereafter, the dual movement of the wheel will result in the ship's course being automatically recorded on the chart irrespective of the precise alignment of the chart relatively to the ship's structure.

In the original design, as previously described, the chart was mounted on an iron-covered table, and the wheel was magnetised in order that it might adhere to the chart surface and not move with the rolling, pitching, or other accidental movement of the ship, including shocks, as from gun firing. In the new design—see Fig. 2—the iron-covered table is dispensed with, and the wheel is not magnetised. Accidental movement of the wheel under inertia forces is obviated by balancing the component

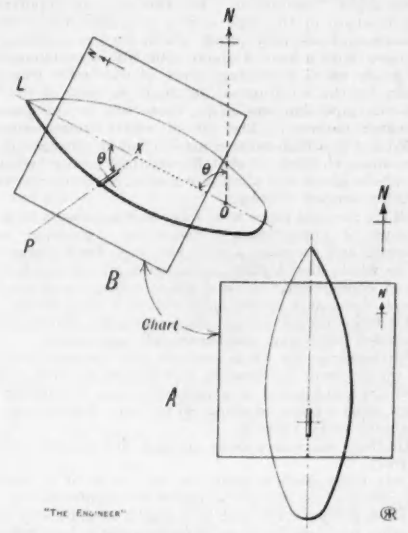


FIG. 1—SHIP AND CHART WHEEL MOVEMENTS

parts of the instrument about their turning points. The achievement of such balance has been rendered possible by removing the mechanism which operates the dual movement of the wheel from the neighbourhood of the wheel itself, and concentrating it in a box at the end of the first arm of the parallel motion work. The second arm carrying the wheel at its end is balanced by a counterweight. The fact that the instrument is in balance in all positions has the additional advantage of allowing the chart board to be placed either horizontally or in any inclined position which may be as nearly vertical as will give sufficient pressure between the pen and the chart to permit the pen to record.

As in the original design, the wheel is mounted at the centre of a horizontal revolving frame, which is free to turn in azimuth with the wheel. This frame carries a

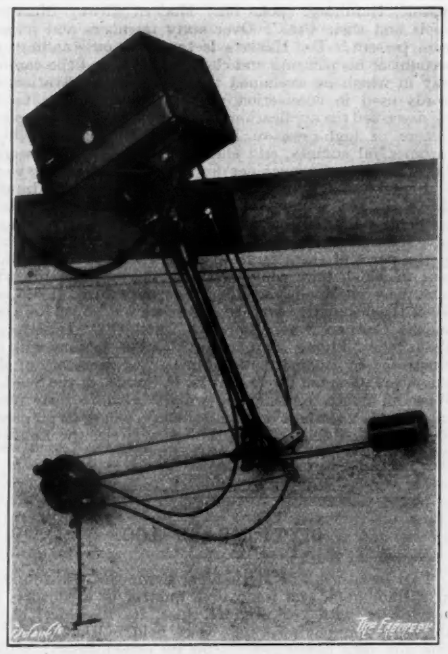


FIG. 2—IMPROVED PATTERN OF ODOGRAPH

pointer in the plane of the wheel, which pointer reads against a graduated ring surrounding the frame and fixed to a carriage. The ring may be marked either with the points of a compass card or in degrees. The carriage to which it is attached is mounted at the end of a set of jointed parallel arms similar in principle to the familiar "drafting machine" of the drawing-office. The carriage actually forms the fourth link of the second parallelogram. It is therefore free to move to any point on the surface of the chart, but in so moving it remains "parallel with itself"—that is to say, it does not rotate about any axis. This parallel motion of the carriage is such that the north point of the graduated ring mounted on it remains constantly aligned towards the north of the chart. The initial action of setting the wheel at the outset of the voyage consists of turning the wheel and its frame about the vertical axis until the pointer on the frame is opposite the mark on the graduated ring agreeing with the heading of the ship relatively to the true north, as read from the ship's gyro-compass. Thereafter, the carriage is moved over the chart surface in accordance with the dual movement communicated to the contained wheel.

The ship's course may be considered as being indicated by the ensuing succession of points of contact between the wheel and the chart. No ready means of recording these points of contact is available, and in any event the carriage would hide them for some considerable time after they had been recorded. Both these difficulties are overcome by fixing a pen arm to the carriage. Two alternative fixing points are provided, and that one is chosen which will leave the projected course of the ship the least obstructed by the parts of the instrument. At the outset of the voyage the arm and the position of the pen upon it are adjusted until the point of the pen is on the chart at the position corresponding to the ship's known position at the instant. This transference of the recording of the course from the point of contact of the wheel with the chart to the point of the pen does not introduce any error. Since the pen arm is fixed rigidly to the carriage, and since the carriage is constrained to preserve its north point constantly aligned towards the north of the chart, the course marked by the pen is geometrically identical with the path of contact between the wheel and the chart.

From the gyro-compass repeater system and from the electrical log relay system, separate cables are led to a connection box mounted on the ceiling or wall of the chart room. From this box a flexible six-core cable is taken to the instrument. The gyro-compass circuit operates a step-by-step motor in the casing of the instrument, which follows up the movements of the master compass. The movements of the step-by-step motor are transmitted through gearing and a flexible wire drive from the casing to the revolving frame surrounding and supporting the wheel. The azimuthal movement of the wheel is claimed to reproduce the compass movement with an error not exceeding ten minutes of angle. The intermittent electrical impulses received from the log relay circuit are transmitted to a solenoid inside the casing. The core of this solenoid is pressed by a spring against an adjustable stop, and, when an impulse passes, is caused to travel away from this stop until it reaches a fixed stop. The amount of lineal movement of the core produced by an impulse can be varied by altering the position of the adjustable stop. This adjustment is made by means of a scale on a divided drum showing inches per mile, and enables the instrument to be adapted to operate on charts covering a wide range of scale. During the passage of an impulse a magnetic clutch is energised and connects the core to gearing, from which a flexible wire drive transmits the movement to the wheel and causes it to rotate on its axle. When the impulse has passed the magnetic clutch is de-energised, and the core is disconnected from the wheel, and is free to return against the adjustable stop. The magnetic clutch in effect serves as a ratchet feed mechanism possessing an infinite number of teeth.

South African Engineering Notes.

(By our South African Correspondent.)

Busy and Prosperous Year Expected.

IN all parts of South Africa there is a conviction that the country has weathered the worst of its troubles and that 1934 will be a year of recovery and steady progress. The drought, which has been general all over the country, and in some parts had lasted four years, has been broken nearly everywhere, streams and rivers which had dried up are now flowing once more, springs are gushing again and the underground waters have been restored to their normal level. This has enabled ploughing operations to be once more carried on, and the prospects for next season's crops are excellent, and generally the agricultural and business outlook is more hopeful now than it has been since the end of 1929. The departure from the gold standard has been followed by an era of prosperity. Increased revenue to the Government, to the extent of £6½ millions, as well as increased activity on the Rand, has resulted from the increased value of gold. All that is required to set in train huge programmes of mining and industrial expansion is relief from the uncertainty of the American policy and the general financial experiments being made overseas. The starting up of the Pretoria Steel Works should give a further impetus to the establishment of more industries, and several overseas firms are already negotiating for sites for the erection of factories and works for the manufacture of their specialities from the steel to be produced by the new works.

Some 1934 Undertakings.

Mr. Pirow, Minister of Defence and Railways, has been discussing with Sir John Siddeley the possibility of an aeroplane engine factory at Roberts Heights, Pretoria, for the construction of aeroplane engines suitable to South African conditions, so as to make the Union Air Force self-contained. Sir John has detailed the conditions under which his companies would consider the erection and equipping of such a factory, but a higher financial contribution from the Government than the Cabinet is prepared to sanction at present is required. American and German aeroplane engine builders are interesting themselves in Union aviation and wish to come into the market for the Air Force requirements. It is understood that, apart from the question of the erection of an aeroplane engine factory, Sir John Siddeley's company has acquired a £5000 hangar at the Germiston air port near Johannesburg, where all repairs and other work required by the Imperial Airways, such as can at present only be done at Croydon, will be carried out as well as work for the Union Airways and other aircraft companies or private owners. There is a general move on the part of municipalities in the Union to discard their tramway systems and replace them by trackless trams or oil-engined omnibuses. Durban Council is calling for tenders for four oil-engined single-decker motor omnibuses, which are expected to cost £6000, and twenty-two electric trollybuses. If the experiment has satisfactory results the substitution of oil-

engined or electric trollybuses for the present tramcars will be proceeded with, one route after another being converted. Cape Town tramways are run by a private company, and at the annual meeting in December the chairman foreshadowed the use of trackless trams on most routes, except the Sea Point to Mowbray line. The chairman stated that the expenditure required to keep the company's tracks in proper condition had increased and would continue to increase, owing to the fact that some of the tracks had reached the stage when they would have to be relaid. The Port Elizabeth tramways are owned by the same company really, though there is a local board of directors there also, so that if trackless trams are generally adopted for Cape Town the same policy will, no doubt, be followed at Port Elizabeth. The Paarl Town Council has decided to accept the tender of Stewarts and Lloyds (S.A.), Ltd., for the supply of the cast iron pipes for the town's £134,000 sewerage scheme. The original intention was to use cement pipes, but it was found that cast iron pipes would be much more satisfactory and the cost would not be much greater. Pretoria City has now completed specifications for the extension of the municipal power station to provide for the extra needs of the new iron and steel industry established there. The estimated cost is £250,000 and tenders are being called for.

Another Gigantic Dam.

In addition to the building of the Vaal-Hertz Dam, which is to cost £4,000,000, irrigate over 120,000 acres, and give employment during construction to 3000 men at present out of work, the Government has decided to begin work on the construction of the Knoppiesfontein Dam, on the Vaal River, which will also give employment to 3000 men. This is a vast project and undoubtedly by far the greatest of its kind ever attempted in the Union. Actually this dam will form a lake covering an area of 50 square miles, and at its maximum capacity 100ft. deep. On the Orange Free State side it will extend up the Wilge River to within a few miles of Frankfort, while its northernmost shore will be close to the railway station at Villiers, Transvaal. It will afford continuous supplies of water for the irrigation of farms over a large area in both provinces (O.F.S. and Transvaal), besides providing about 50,000,000 gallons of water a day for consumption in Johannesburg, the Reef towns and mines, and possibly Pretoria.

New Textile Mill.

M. Mauerberger, Ltd., of Cape Town, have purchased 8½ acres of municipal land at Chiselhurst, near East London, upon which the erection of a £10,000 textile mill has now begun. It is expected that some 500 people will eventually find employment in the various departments. In addition to a large weaving section in which modern looms will be installed, a spinning plant is being erected for manufacturing the yarns required for the making of cotton and woollen blankets, rugs, Kaffir shawls, sheeting, and so on. This firm has already established textile mills at Huguenot (Paarl) and at Industria (Johannesburg), where both spinning and weaving are carried on. A large clothing factory is also operated by the firm in Keeronust, Cape Town.

Main Line Electrification.

Parliamentary sanction will probably be sought in this session for the electrification of the main Natal line to Newcastle and from Glencoe Junction to Vryheid at a cost of roughly £300,000, while the reorganisation of the railway system of the Rand and its possible electrification is, it is understood, engaging the attention of the railway administrations' engineers. A scheme for the supply of current to the sugar mills on the Natal north coast is to be the subject of discussion between the Electricity Supply Commission and representatives of the sugar industry.

Mishap at New Steel Works.

A subsidence in the foundations of one of the ore crushing plants at the South African Iron and Steel Works, Pretoria, has caused fears that the start of the output will be delayed. Information from the works, however, is to the effect that the mishap is not serious and is unlikely to interfere with the progress of the plant in reaching the producing stage in March of this year.

New Equipment for Railways.

Parliament is to be asked this session to sanction the expenditure of £600,000 on rolling stock. Included in this will be an order for fifty new engines of the 19A class. These engines are intended principally for branch lines and will replace old and obsolete locomotives. For some years there has been a severe curtailment of orders for new rolling stock owing to the depression and falling railway revenue, but with traffic showing great improvement the ordering of new rolling stock is imperative.

The Accident at Lac Noir.

As reported in the daily papers, a pipe line burst at the Lac Noir power station between 9 and 10 p.m. on January 4th, as a result of which nine people lost their lives and considerable damage was done.

The Lac Blanc and Lac Noir, both natural lakes, are situated to the west of Colmar, almost on the crest of the Vosges Mountains. They have an average difference in elevation of 115 m., and the horizontal distance separating them from one another amounts to a little more than 1 kilom. These favourable hydraulic conditions were utilised by the "Energie Electrique du Rhin," the owners of the Kembs power station, for a pumping storage plant, built to meet peak load requirements. Superfluous energy available at the Kembs plant is to be employed to pump water from Lac Noir, which is at a lower level than Lac Blanc. The water stored in the latter lake is to be employed in the power-house at Lac Noir for the production of energy to meet peak load requirements. The storage plant is run by an associated company under the style of the "Société Hydro-Electrique des Vosges." The Escher Wyss Engineering Works, Ltd., carried out the contract for the hydraulic plant.

We are indebted to Messrs. Escher Wyss for the following information about the accident:—The connecting angle of a manhole in the distributing piping burst, as a result of two faults hidden in the material, at static pressure and owing to fatigue. This tore open the distributing piping for a length of about 7·5 m. and for a width of about 2·5 m. The fracture is in no instance at a point where the welded seam had been made, nor does it at any point run parallel to a weld at a short distance therefrom. The fractured surface, about 20 m. in length, in the plate of 36 mm. thickness, is absolutely sound throughout, up to a single point which shows slight "lamination," but this is of no importance. This fracture in the pipe caused a sudden reduction in pressure and the only pump which was in operation at the time, with a load of about 8000 kW, was damaged in the guide wheel regulating gear, as the latter was held rigidly by the servo-motor, so that, in view of the fact that the pipe line was open, there can be no question of water hammer. The jet of water which emerged fouled the first high-tension mast which is arranged in the immediate vicinity of the distributing piping, whereby the whole plant was shut down as a result of the short circuit produced thereby.

All the straight pipes were subjected separately to a test pressure of approximately twice the maximum static pressure, and received a very thorough hammering test.

The whole distributing piping with all valves, throttle valves, connections, &c., and the aforementioned manhole branch were, as a whole, subjected to a three hours' test under twice the maximum static pressure, during which all welded joints were also thoroughly hammered.

Furthermore, the whole pressure pipe line and distributing piping from the forebay downwards was one month later again subjected to a test, this time lasting for ten hours, with a pressure about 80 per cent. higher than the maximum static pressure.

All these successive tests are specified in detail in the contract.

That these hidden faults in the metal of a manhole connection which did not belong to the equipment supplied by Escher Wyss could not be brought to light with these exacting test conditions is unfortunately a fact, but this certainly does not entitle one to infer that the plant is defective or that its general execution is faulty.

The deplorable loss of so many lives in consequence of this pipe fracture is attributable to a chain of unfortunate circumstances, the explanation of which will be the work of the committee of investigation which has been appointed for the purpose. However, the particulars which we have collected already warrant our stating that the work carried out by the Escher Wyss Engineering Works, Ltd., is in no way responsible for the catastrophe.

ENGINEERS' GERMAN CIRCLE.

THE first of the second series of lectures arranged by the Engineers' German Circle took place on Monday evening last, at the Institution of Mechanical Engineers, when Dr. Ing. H. Haake, Professor at the Technischelehranstalt, Hamburg, spoke on "Modern Heavy Machine Tools and their Use." Over sixty members and guests were present. Dr. Haake's lecture was outstanding on account of his pleasing and clear delivery, and the careful way in which he explained the origin and derivation of words used in connection with modern machine tools. He described the applications of machine tools in the manufacture of high-pressure boilers, steam turbines, water turbines, oil engines, and chemical and motor car work. Two of the largest machines described by the lecturer were a 10,000-ton forging press constructed by Hydraulic G.m.b.H., and a gigantic boring and turning mill built by Schiess-Defries for water turbine work. Dr. Haake gave some interesting particulars with regard to the casting of the parts of these large tools, and explained the wide uses to which they could be put. The next lecture will take place on Monday evening, February 26th, at 6 p.m., when Reichsbahnrat Stroebe will speak on "Fast Railcars on the German State Railways," and the "Oil-electric Train, the 'Flying Hamburger.'" The lecture will be illustrated by cinematograph films. The Secretary of the Engineers' German Circle, Mr. H. P. Spratt, of the Science Museum, South Kensington, will be glad to hear from engineers, who, when visiting Germany, would be prepared to lecture in English before the sister circle, the English-speaking German Engineers in Berlin.

SIXTY YEARS AGO.

THE Institution of Mechanical Engineers was founded in Birmingham, and for over a quarter of a century, in accordance with the original rules, its meetings, other than the summer meetings, were held in that city. It was not very many years after its establishment before some of the members began to express the view that Birmingham was not the most suitable place for its headquarters and its meetings. Sir Joseph Whitworth was one of the earliest advocates of a change, and recommended that the Institution should be moved bodily to Manchester. Nothing came of that suggestion, but the volume of opinion in favour of a removal continued to increase from year to year. The question was brought to a head at the twenty-seventh anniversary meeting, the proceedings at which were reported in our issue of February 6th, 1874. In May, 1873, the quarterly meeting—the Institution in those days met only four times a year—had been held as an experiment in London instead of Birmingham. The attendance at that meeting had amounted to 185 members and visitors, as compared with an average of 66 at four recent meetings in Birmingham. The implication of these figures was seized upon by certain members, and at the anniversary meeting a strong movement to break away from Birmingham developed. Mr. A. Paget led the attack. He thought that for an Institution with a membership roll of 950 the attendances at its meetings were less than what they should be. He therefore urged that other meetings in London should be arranged, in order to discover whether the success of the experiment already tried would be repeated. The Council at that date numbered seven who resided in London and only one whose home was in Birmingham. It appeared to look favourably on Mr. Paget's suggestion, but it hesitated somewhat because it felt that it might eventually lead to the complete transference of the Institution and all its activities to London, a development for which the Council was not then fully prepared to take responsibility. Other members opposed Mr. Paget's suggestion to the extent of urging the claims of their own cities. Thus Mr. J. Robinson submitted that at the Council's discretion meetings might be held in Manchester, while Mr. Brown proposed Glasgow as another alternative. Some members expressed the fear that the Institution might become a wandering body, like the British Association, while others argued that if it established itself in London it would weaken itself by coming into conflict with cognate institutions. The Birmingham members—they seem to have numbered 69 in all—held that the Institution was essentially a Birmingham body, and that great risk would be involved in transferring it to London. They were quite convinced that the movement on foot to hold more meetings in London was merely the beginning of the removal of the Institution away from Birmingham, and some of them threatened to resign if that change were made. After much debate, the members agreed to amend the rules to the extent of adding "or London" after the word "Birmingham" in the paragraph prescribing the place of meeting. To-day the growth in the number and strength of the Institution's provincial branches may perhaps be considered as having provided a compromise between the conflicting views and recommendations advanced at the meeting of sixty years ago.

A NEW ENGINE FUEL.

THE new motor spirit Cleveland-Discol, which has been put on the market by the Distillers Company, Ltd., and the Petroleum Storage and Finance Corporation, Ltd., is an alcohol-petrol blend for which special advantages, compared with a straight petrol, are claimed. Some of these advantages were referred to at a luncheon held in London last week. An important feature of the fuel is that the benzole equivalent or anti-knock value can be directly adjusted to the exact compression ratio of the engine in which the fuel is to be used. This will, it is claimed, enable motor car manufacturers and petrol engine builders to obtain a larger output from a given size of engine, or to use a smaller size of cylinder for a given output with a correspondingly smaller fuel consumption. Again, the high latent heat factor of the alcohol content reduces engine temperature and promotes more efficient induction, while the high volatility of the alcohol gives a good starting characteristic. These characteristics have been carefully determined in a prolonged series of tests extending over eighteen months, which have been carried out by Dr. Ormandy and Mr. Harold Moore, and have included tests on three variable compression engines and actual road tests. The tests indicate a virtual elimination of carbon deposits and a corresponding reduction in valve troubles. For the present the fuel will be supplied in summer and winter blends, but as higher compression ratios are introduced, the anti-knock value will be increased to meet the new requirements.

CALENDARS, DIARIES, &c.

AUGUST'S LTD., Halifax.—Wall calendar.

HARLAND AND WOLFF, Ltd., Belfast.—Wall calendar.

WELBECSON PRESS, Ltd., Blenheim House, Blenheim-crescent, W.11.—Wall calendar.

WORTHINGTON, MACKENZIE AND CO., Ltd., Phœnix Works, Stockton-on-Tees.—Wall calendar.

EDUCATIONAL INTELLIGENCE.

UNIVERSITY OF LEEDS.—A course of seven lectures on "Gaseous Electrical Conductors," designed for graduates and junior engineers, is being given in the Electrical Engineering Department of the University by Professor E. L. E. Wheatcroft, at 7 p.m. on consecutive Monday evenings commencing on February 5th.

FARADAY MEDAL.—The Council of the Institution of Electrical Engineers has made the twelfth award of the Faraday Medal to Sir Frank E. Smith, F.R.S.

MACHINE TOOL EXHIBITION.—The Machine Tool Trades Association has taken the Main Hall and Annexe at Olympia from October 29th to November 30th, 1934, for the holding of the fifth Machine Tool and Engineering Exhibition. The opening day has been fixed for Thursday, November 8th (thus allowing ten days for the installation of exhibits), and the closing day for Saturday, November 24th, so that the Exhibition will be open to the public for seventeen days, including three Saturdays.

INSTITUTION OF MECHANICAL ENGINEERS.—The Council has made the following awards for papers:—Thomas Hawksley Gold Medal: Mr. L. W. Schuster, M.A., for his paper on "The Investigation of the Mechanical Breakdown of Prime Movers and Boiler Plant." Thomas Hawksley Premiums: £7 each to Mr. E. W. Robey and Mr. W. F. Harlow, for their paper on "Heat Liberation and Transmission in Large Steam Generating Plants." Thomas Lowe Gray Prizes: £15 each to Mr. R. F. Davis, B.Sc. (Eng.), and Mr. A. L. Timmins, B.Sc. (Eng.), for their paper on "Some Technical Aspects of High-pressure Boiler Design"; £10 to Mr. Robert Russell, B.Sc., for his paper on "Factors Affecting the Grip in Force, Shrink, and Expansion Fits." T. Bernard Hall Prizes: £20 to Mr. V. E. Pullin, for his paper on "Radium in Engineering Practice"; £15 to Professor Frederic Bacon, M.A., for his paper on "Fatigue and Corrosion Fatigue with special reference to Service Breakages." George Stephenson Research Prize: £20 to Mr. S. R. M. Porter, M.A., for his paper on "The Curving of Locomotives A Method of Calculation for Designers and Others."

Railway and Road Matters.

AT the annual winter dinner of the Permanent Way Institution on January 27th, the President, Mr. Arthur R. Cooper, said that at its jubilee this year the railway companies were going to give tangible assistance, so that the event might be suitably commemorated.

STATISTICS as to the operation in London of omnibuses, tramways and the Underground Railways are contained in the recently issued annual report of the London and Home Counties Traffic Advisory Committee. It is a Stationery Office publication, price 2s. 6d.

As was announced herein on November 17th last, the L.N.E.R. Company has placed a contract for the provision of colour light signals on the Seven Sisters and Enfield branch. Colour light signals are at present being installed between Hackney Downs and Seven Sisters, and an order has already been placed for a similar installation between Clapton and Hackney Downs.

THREE of the four 2–6–0 type locomotives recently constructed at the L.M.S. Railway's Derby works for the Northern Counties Committee section are to be named after important rivers in Northern Ireland, as follows:—No. 91, "The Bush"; No. 92, "The Bann"; and No. 93, "The Foyle." The first engine (No. 90), the "Duke of Abercorn," gives its name to the class.

THE *Great Western Railway Magazine* for January gave some interesting figures as to the prices paid by that company for material in 1932 and 1933, as compared with 1913. In all cases the prices paid in 1933 were lower than those of 1932. Taking the 1913 figures as 100 in each case, the ratios for 1933 were: General stores, 91; iron and steel, 134; timber, 145; special contracts, 102; coal for stations and staff, 137; and total, 109.

THE *Railway Newsletter* for February gives the traffic receipts for the first three weeks of 1934, 1933, and 1932. The totals were £7,709,000, £7,184,000, and £7,881,000 respectively. Of the £525,000 increase this year over 1933, £376,000 came from merchandise and £137,000 from coal. In the comparison between 1934 and 1932 coal has an increase of £34,000, merchandise a decrease of £60,000, but passenger traffic was down by £146,000.

THE late Lord Aberconway, who died on January 23rd, became a director of the Metropolitan Railway in 1895, deputy chairman in 1902, and chairman in 1904. As that railway ceased to be a separate entity as from July 1st last year, he may be said to have held the last-named office for thirty years. Because of its joint working with the former Great Central, and its goods traffic over the "widened line," Lord Aberconway refused to regard the Metropolitan as a local line.

CONSIDERABLE opposition is being shown to the proposals, shortly to come before Parliament, of the London Passenger Transport Board to run trolley vehicles; especially is that so over the intention to make Bedford-square a terminus for those vehicles. It is significant, however, that the London County Council, on January 30th, approved, without comment, the proposals in the Board's Bill as far as relates to the introduction of trolley vehicles as a means of transit in London.

DURING the three months ended on June 30th last, the assistant inspecting officers of the Ministry of Transport held forty-one inquiries into the more serious of the accidents to railway servants. Thirteen of them related to fatal cases and the inspecting officers' reports assigned the various causes as follows:—Misadventure, five; want of care on the part of the deceased, five; want of care on the part of a fellow servant, one; forgetful of his own safety, one; momentary lapse of memory, one.

THE coroner's jury on the 1st inst. returned a verdict of "Accidental death" in the case of the driver killed in Watford tunnel on January 29th under circumstances related in our Seven-Day Journal of February 2nd. From the evidence of the Watford shed foreman, it would seem that a smoke tube burst, and the coroner was of the opinion that the steam from the fire-box caused the unfortunate man to step back and to fall off the engine. The engine in question was retubed in 1931. The life of the tubes was about five years, and some were renewed in September last. The tube which burst was thin.

CONSIDERABLE alterations in the signalling at Stafford, L.M.S. Railway, have recently been in hand. On the main line towards Crewe an "advanced advance" section in each direction has been introduced, whereby the signal-box at Tillington has been dispensed with and the up signals there are now controlled from Great Bridgeford and the down signals from Stafford No. 5 box. On the line to Stafford the boxes at Bickerscote and Cooper's Crossing have been eliminated, and, by an "advanced advance" section, the down signals are controlled from Penkridge Goods box, and similarly the up signals from Stafford No. 1 box. Stafford No. 4 box has been replaced, and the new box, with a locking frame of 135 levers, was opened on Sunday, February 4th.

THE late Mr. G. J. Churchward was a co-patentee with Mr. Dean of a wagon brake which actually complied with the Order issued by the Board of Trade on April 27th, 1901, in accordance with the Railway Employment (Prevention of Accidents) Act, 1900. That called for "either-side brakes," *i.e.*, brakes on each side of a wagon which could be applied or released from either side. But though the Great Western, by the Dean-Churchward brake, achieved that, the other railway companies were less successful, and the Railway Employment Safety Appliance Committee thereupon reported that, having regard to the fact that the need of a brake capable of being applied from either side was greater than that of a brake that could be released from either side, a new Order should be made requiring a brake which could be applied from either side. That Order was issued in 1907, and was at once objected to by the Great Western company which took the case to the Railway and Canal Commission, which upheld the objection on the ground that the Dean-Churchward brake did not involve danger, and that it tended to diminish the risks incidental to railway service. The Order was thereupon amended on November 7th, 1921, so as to cover the Dean-Churchward brake also. Its use has since been abandoned.

Notes and Memoranda.

GOOD results in etching mild steel may be obtained with a solution of copper chloride, hydrogen peroxide, alcohol, and hydrochloric acid, according to Mr. M. Kodama, of Tokyo.

BENDING and torsional tests on test rolls of plaster to determine the strength of and stresses in roll necks were described by Mr. H. Trinks and Mr. J. H. Hitchcock before the American Society of Mechanical Engineers. The test rolls were of various dimensions and were rounded off to different contours. The results obtained are compared with those previously obtained and indicate the most suitable design of rolls and contours consistent with maximum strength.

A NEW, easily cleaned, weather-resistant aluminium reflector material has been introduced by the Aluminium Company, of America. It is made possible by the Alray process, an electrolytic brightening method which gives white sapphire surfaces or diffusing frost-like appearing surfaces of reflectivity up to 87 per cent., as compared with normal aluminium of 74 per cent. reflectivity. This aluminium material has a finish highly resistant to weather, fumes and stains, and can be easily cleaned with soap and water. The finish is an anodic oxidised coating, hard and transparent.

IN a lecture before the Overhead Lines Association, Mr. J. F. Shipley emphasised the existence of an electric stress in the atmosphere as distinct from lightning, caused by the presence of a voltage gradient which always existed and could be measured. The range of a lightning flash might be from ¼ to 3 miles and the voltage which caused it was roughly 1000 millions. The "strike" lasted for perhaps twenty millionths of a second and the amount of energy dissipated in that short time might be of the order of 3000 kWh. There were always 1800 lightning strokes occurring at any one time on the earth, and if these were assessed at 100 per second, the total amount of energy being spent on the earth from electrical causes was roughly 9½ million million kWh.

IN a discussion on bearing finish in *Machinery*, Mr. J. H. C. Atkins gives the following experience of a white metal split bearing, in which ran a hardened and burnished Ubas spindle. The bearing was broached and burnished to remove all tool marks before splitting, and finally scraped in position. The spindle ran hot, and after a short time the bearing had a mirror finish all over. When this stage had been reached the wear appeared to cease altogether, although still running too hot to touch. The clearance was about 0·00025in. Some difficulty was experienced in the matter of lubrication, but with pure sperm oil the bearing gave consistently excellent results. After months of running, any attempt to adjust the bearing caused the spindle to pull up immediately.

THE Noeux-les-Mines collieries in France have, according to *Iron and Coal Trades Review*, been experimenting with a process for producing smokeless fuel called "Anthracine," which is claimed to have the same heating power as anthracite at a saving of about 25 per cent. in cost. This fuel is made from dry steam or anthracite smalls under 10 mm. in diameter, which are washed in the Rheolaveurs of the colliery, thus reducing the ash content from over 20 per cent. to 6 per cent. The product is then pulverised, mixed with 9 per cent. of pitch and briquetted in special presses, each of 30 tons per hour capacity. The briquettes are finally heated to 700 deg. Cent. to drive off the pitch, leaving a fuel which burns without smoke or odour in the domestic grate. The calorific value is stated to be 7000 calories.

VARIATION in the concentration of oxygen in the soil surrounding a metallic pipe is probably the most important factor in determining the rate of subsoil corrosion, according to Mr. A. H. Logan, of the American Bureau of Standards. The Bureau found that the character and extent of soil action varies with the soil conditions more closely than with the character of the pipe material. The rate of corrosion decreases materially after a few years of exposure to the soil, first because settling of trench material makes oxygen concentration in the soil more uniform, and second because deposited corroded material on the pipe offers protection. The conclusion reached was that differences in oxygen concentration are of more importance than either soil acidity or differences in electrical potentials between adjacent portions of the pipe line.

EQUIPPED with special apparatus attached to the wings, a three-engined British air liner, says *Flight*, is to be employed in Rhodesia to spread a poison barrage before swarms of locusts as they pass over the country, in an effort to destroy them before they settle. Mechanism devised to spread a fine curtain of sodium arsenite powder has been sent out from England to Broken Hill, where it will be fitted to the aeroplane. Immediately locusts are reported the machine will be taken up to locate them; once the swarm is found the pilot will steer the machine along its front, spraying poison into the air in the hope that the locusts will fly into it. Three hundred pounds of the poison powder can be carried on the machine and, because the powder is fine enough to remain suspended in the air for some time, there is ground for hope that the swarms will largely be destroyed.

THE Swiss Federal Railways are shortly going to introduce, starting on the main lines, a system of automatically stopping trains which prevents them going past signals set against them and colliding with other trains, states a note in *Electrical Industries*. After many trials the railways have decided in favour of an electromagnetic system which is quite unaffected by atmospheric conditions, frost, snow, and rain, and is made by a Zurich factory. A magnet is placed on the permanent way near the first signal, and works an apparatus on any engine passing a signal set against it. The driver, warned by a siren, can stop the train at the second signal. If he fails to do so the electric current is automatically cut off and the compressed air brakes put into action, stopping the train immediately. Further safety is ensured by the fact that if the system gets out of order in any way a train can still be stopped. The trials carried out some time ago on the Berne-Thun line have shown that the new system works perfectly at all speeds.

Miscellanea.

AUSTRALIA imported 7220 British unassembled motor car chassis in the financial year 1932–33, against 2447 in the previous year.

IN a pamphlet of fifty-nine pages the Industrial Health Research Board has succeeded in proving that payment by the piece is an incentive in repetition work.

THE new British flotilla leader being constructed at Portsmouth has been named "Exmouth." It will be our largest destroyer, and have a speed of 36 knots.

AT a conference of colliery safety workers, Mr. W. T. Miller said 760 lives were lost in underground work during 1933, which, he believed, was the lowest number on record.

IT is reported that Colvilles, Ltd., have rolled at their Dalzell Steel Works, Motherwell, a steel plate 35ft. long, 6½ft. wide, and 4¾in. thick, and weighing nearly 22 tons.

IT is reported that the Southern Railway Company's 60,000 tons floating dock at Southampton is to be disposed of. With an overall length of 960ft., this is the largest floating dock in the world.

CONSTRUCTED for the purpose of a railhead distribution centre, the largest railway-owned warehouse in the City of London has just been completed by the L.M.S. Railway at its depôt at Haydon-square.

ACCORDING to a recent report, the contract has been secured by the Marconi Company for the reconstruction of the Swedish broadcasting station at Motala. The power of the station will then be 150 kW.

THE Postmaster-General announces that the weight of letters sent by air from this country during 1933 was the largest ever recorded in one year, and amounted to about 85 tons, as compared with 64 tons in 1932.

THE world consumption of tin during 1933 is estimated at 127,000 tons, an increase of 25 per cent. as compared with 1932. Tin-plate production in 1933 amounted to some 3,200,000 tons, an increase of 40 per cent. on the 1932 figures, the quantity of tin used being about 51,500 tons.

LOUDSPEAKERS have been installed at the Mines de Bruay for intercommunication purposes, and microphones affixed to sides and roofs and connected with amplifiers to give an amplified audible warning of movements in the roof to all men working in a particular district.

THE seventy-fifth Annual Meeting of the Institution of Naval Architects will take place on Wednesday, March 21st, and the two following days in the Lecture Hall of the Royal Society of Arts, John-street, Adelphi, W.C.2. The Annual Dinner will be given on Wednesday, March 21st, at 7.30 p.m., in the Grand Hall, Connaught Rooms, Great Queen-street, Kingsway, W.C.

THE Czechoslovak State Railways are reported to have a motor rail car under trial which uses wood gas for fuel. Should the trials be successful, all rail motor cars now in use will be equipped with wood-gas generators, and the use of petrol discontinued. Czechoslovakia has more than sufficient wood suitable for this purpose, and it is expected that even old cross-ties might be used as fuel.

DURING the forthcoming Paris Trade Fair (May 9th to 24th), a competition open to all kinds of new inventions will be held as on previous years. These inventions must not have taken part in any other previous competition. Applications for admission to the competition should be sent to the offices of the Paris Trade Fair, 17, Tothill-street, London, S.W.1, not later than March 1st, 1934.

THE annual statement of progress shows that there are now 244 telephone exchanges in the London area, 72 of which are automatic, 162 manual, four trunk, two toll, and four tandem. At the end of 1933 the number of direct exchange lines in use was 477,000, an increase of 14,000, or 3 per cent. Telephones increased by 33,000 to 820,000, and the number of calls grew to nearly 800 millions, an increase of about 7 per cent. The average number of calls originated weekly rose by a million to 15·3 millions.

A COMPLIMENTARY dinner to Mr. W. Bernard Challen, M.I. Mech. E., was given at the Queen's Hotel, Birmingham, on the evening of Wednesday, January 31st, Mr. R. A. Chattock presiding in the absence of Sir Gilbert Barling, who was unavoidably prevented from attending at the last minute on doctor's orders. The dinner was organised by the institutions and societies which make use of the James Watt Memorial Institute, as a token of their appreciation of the untiring efforts of Mr. Challen to bring the scheme to fruition. As a further mark of appreciation, Mr. Challen was presented with a silver coffee set.

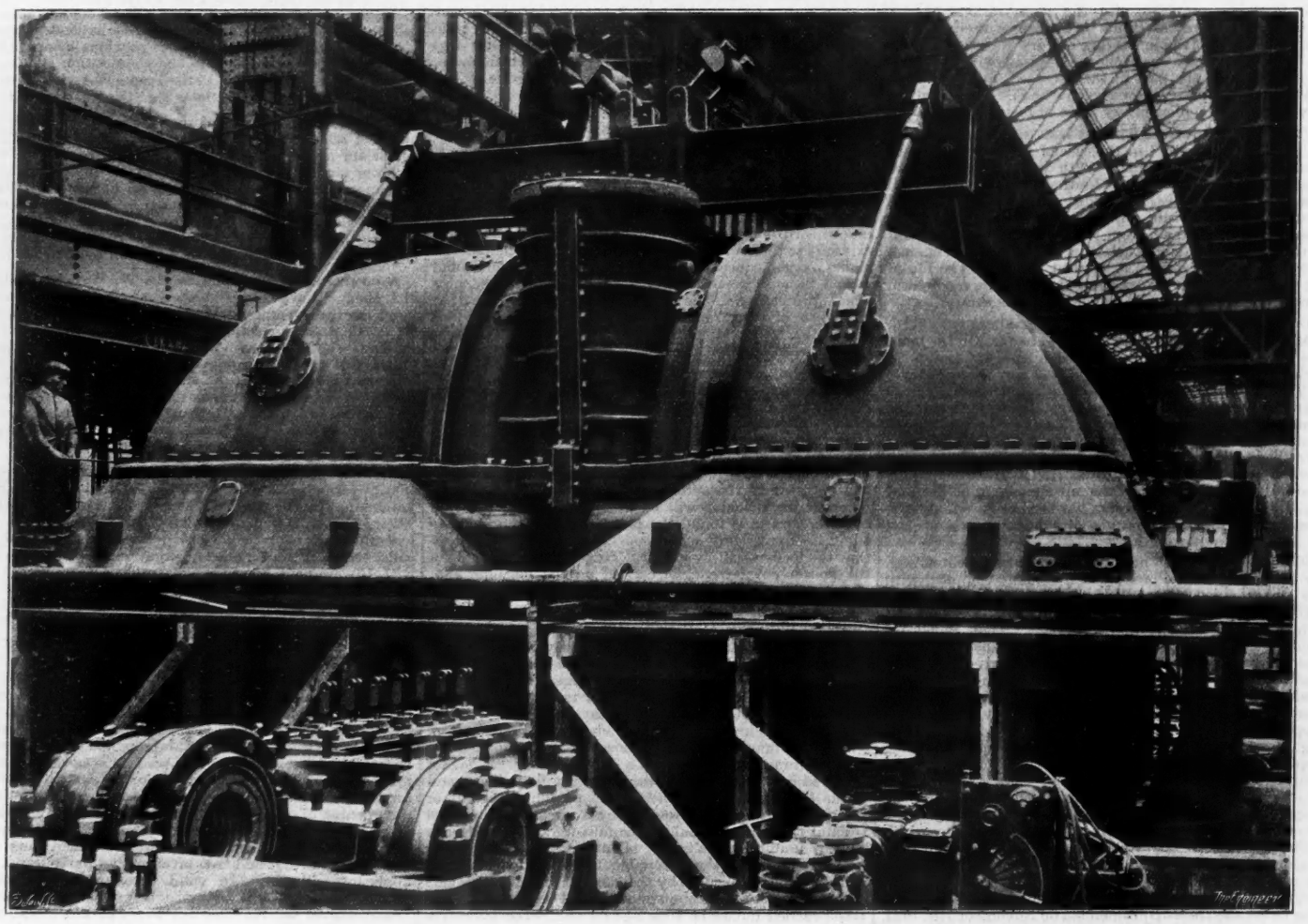
A TELEPHONE has been devised and brought into operation by farmers of the Lacordaire district, in Southern Saskatchewan, by the use of barbed wire and old motor cars. Their 50 miles of telephone circuit is routed over barbed wire fences and does service for every-day gossip and business calls, while, in an emergency, they can get connections with Government lines for calls. The local people took old radio headphones, says *Canada*, and batteries from old cars, and put barbed wire fences into use as a telephone line. At first ten farmers were on the circuit. Now there are thirty along 50 miles of line. And some families, without radio sets, get radio programmes over the barbed wire telephone line, with loud speakers in their homes.

THE Institute of Patentees points out to exhibitors at the British Industries Fair the danger of taking advantage of Sections 45 (1) and 59 (1) of the Patents and Designs Act. Under these sections an unprotected invention may be exhibited provided the Comptroller is notified on the prescribed form. An application for patent may be filed for the same invention within six months of the date of the opening of the Fair. However, no priority of date is given, and anyone seeing an invention may file an application for patent in this country and other countries, and unless the first and true inventor can prove fraud, the applicant will obtain a valid patent. A well-known patent counsel in his evidence before the Commission, presided over by Sir Charles Sargeant, dealt with this matter, and endeavoured to have the sections of the Act strengthened, but without success.

THE NEW BARKING POWER STATION

(*For description see page* 144.)

LOW-PRESSURE ROTOR



LOW-PRESSURE CYLINDER

The Engineer

FEBRUARY 9, 1934.

VOL. CLVII. No. 4074

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NOTICES TO READERS.

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INDUSTRY AND THE INDIVIDUAL.

AMONGST the characteristics which distinguish the people of this nation there is none more evident than a spirit of individualism and independence. Under the sun there are no peoples which have so great a reluctance to co-operate, even for their common good. We enjoy opposition and competition; we look upon them as factors which spur us on to greater endeavours; we attribute our successes to them; and we surrender them with misgivings. They have, we say, served us well in the past; why should they not continue to do so? That is our natural, inherent, attitude towards all forms of amalgamation and co-operative action. But it is daily suffering buffets which are hard to withstand. As long as we can recall there has been impatience with "cut-throat" competition. Organisations, some open, some secret, have been set up to counter it. But it is only within recent years that the theory that competition is inefficient has made headway. For the greater part of a century it was believed to be the very breath of industrial progress; now it is being regarded with suspicion, not only because it diminishes profits, but because it is held also to reduce economy of production. What has brought about this change of thought, it is difficult to say. We may surmise, however, that, with the growth of foreign competition and the spread of nationalism, rivalry has reached a point at which it becomes more destructive than energising. But whatever the cause, united action is the order of the day. It is sought by the industries; it is enforced by the Government. Parliament amalgamated the railways; Parliament made the London Passenger Transport Board; Parliament is telling the steelmakers to co-operate or take the consequences. But the great industrial rationalisation which followed the disruption of the war was organised by the industries themselves; the B.E.A.M.A. had an industrial origin; and the shipbuilding industry is responsible for the great endeavour to reduce shipyards to an economical number.

Hence we find the State and the people conspiring to defeat the once-admired competition and destroy our ancient individualism and independence. So far the State has been contented to do no more than persuade or compel. But from that step to nationalisation is not a long one, and if it can be obviated by closer co-operation inside industries, then by all means let us adopt that alternative. "Possibly it is necessary," said Mr. Beaumont Pease, in his admirable address to the shareholders in Lloyds Bank last week, "that some motive force to start such operations should be supplied and directed by Government in times like the present, when so much of our industrial machinery is out of gear, but I do not believe that any Government or any bureaucracy is capable of shouldering the heavy responsibility of saying how the industries of a nation should be run, or that those industries can be active and prosperous when confined in a strait-jacket designed not by those who have to wear it, but by theorists who think they have a genius for planning other people's clothes. . . . Doubtless, the question will be solved on the lines of compromise, so beloved of Englishmen, and in accordance with the aspirations of the Minister of Transport that 'the relationship we have to find lies somewhere between the complete non-interference of the last century and the complete interference of the Socialistic State.'" Speaking at a recent luncheon of the British Engineers' Association, Mr. Bremner, whose finger, in the familiar *cliché*, is on the pulse of the engineering industry, said: "We are at the beginning of a new era, when uncontrolled individualism is going to be a thing of the past. . . . Conditions have undergone such a change that it is inevitable that Governments must intervene in many things affecting the general life of the nation, which were formerly left to work out as best they might under a policy of *laissez faire*." Mr. Bremner holds that little or nothing has been done by the engineering industry "with a view to its rehabilitation as a valuable wealth-producing asset to the nation." He declares that "the industry as a whole is over capitalised and overburdened with a load of debt, and for years those engaged in it have meandered on, pursuing a temporising policy of starvation economy and cut-throat price competition suited only to a temporary emergency." There is a lack of organisation and understanding. "One man gets up in the morning and is very busy trying to neutralise the efforts of someone else who is also getting up early in the morning. The result is that at the end of the day both might as well have stayed in bed." Mr. Bremner's energy expresses itself in a rhetorical manner familiar to and respected by all who know him. He would almost lead us to believe that no profits can now be made in mechanical engineering. But he knows, none better, that there are not a few engineering firms in this country which made fair profits last year, and are likely to make greater this. Need for reorganisation, far more willing and complete co-operation, may, and in some cases undoubtedly does, exist, but, like the iron and steel tariff, it must not be used as a cloak for individual inefficiency, but rather as a device and mechanism for putting the weaker brethren on their feet again. If it cannot do that, if it cannot redeem that element of individualism which, after all, lies under all successful co-operation, then no reorganisation for mutual benefit will bring lasting good.

We seem, then, to come to this. That we must have a measure of Government interference with industry; that we must have better co-ordination between the elements of industry; and, finally, that we must have a pronounced individualism within every firm or unit of industry. For the fact is as true as ever that it is the personal attributes of those who direct an industry that make or mar it. No machinery that Governments may impose or that the corporate judgment of associations may devise, will ever save companies which are badly or weakly directed. The individual is still, as he always has been, the dominant factor in success, and the most and the best that can be hoped from any form of amalgamation, any mutual understanding, any kind of co-operative action, is that it will remove obstacles against which even the best organisers in the world may struggle in vain. We do not want to establish asylums for the industrially feeble, but gymnasia in which the strong may grow stronger.

The Machine Age.

PEOPLE, as a matter of convenience, speak of the Industrial Revolution. It is supposed to have begun somewhere about the end of the eighteenth century, and to owe its origin to the invention of Watt's rotative steam engine, and Arkwright's, and other inventors' textile machinery. A tendency to regard the present age as signalising the opening of a second Industrial Revolution resulting from the dominant position taken by the machine is observable. "Revolution" is a handy word to use in such connection, but it is hardly a precise one. There is no resemblance between these industrial revolutions and social and political revolutions initiated by a *coup d'etat*. The implication in the term that something which has changed the current of affairs has occurred suddenly is false. The Industrial Revolution did not fall instantaneously upon an astonished world. Factories of many kinds existed long before Watt put power at the disposal of all who desired it. The water wheel had supplied energy before steam was harnessed to a shaft, and long afterwards it continued to drive the machinery of small factories and mills. In the same way the present condition has not come suddenly upon the world. The machine tool, as an engineering appliance, is well over a hundred years of age, and in no year of its existence has it failed to show some advance. There is no mechanism of any kind that is not an improvement on something that has preceded it by many years; nothing, not even the motor car or the aeroplane, has sprung suddenly into new existence. The machine, unlike inventions and discoveries in the chemical and physical worlds, can offer us no surprises. It is impossible to think of one that is more than a new combination of familiar parts. Moreover, those combinations were always foreseeable, if not foreseen. It is only necessary to turn up a few pages of that wonderful sketch book of Leonardo da Vinci's to see how much of modern mechanism was potentially anticipated between four and five hundred years ago. Moreover, the progress in the development of the machine has been regular and consistent. There was nothing sudden about the coming of the automatic lathe, or printing machinery, or boot and shoe machinery or knitting machines, and the whole range of textile machines. Even the steam turbine had many predecessors. The machine age has not come upon us like a thief in the night, but it has crept upon us slowly, as a tree grows, or, if we must bow to the pessimism of the day, like some lingering malady, biting into our tissues and only discovered when its ravages have got past remedying.

Hence, if it is looseness to speak of the Industrial Revolution, it is still worse to speak as if the Machine Age also initiated a revolution. All we can say is that the use of the machine is more extensive now than it was ten years ago. But it always was. Pick any decade in the last few hundred years, and you will find that in it the machine was doing something that up to that time had been done by brawn or skill of hand. If, at the present time, we are embarrassed by the perfection of our machines, it is not because we are called upon suddenly and unexpectedly to face their potency, but because we are unable to adapt ourselves to the new conditions which we ourselves have developed. It is as though a man in the buff should, by physical exercises, expand his frame and then complain that his clothes were too small for him. What he needs then is a new suit of clothes; not a less perfect body. That is the case we are in. Our old coat is too tight under the arm pits, it pinches us round the waist, it ruckles up round the shoulders; our wrists stick out awkwardly through the cuffs. Some people would have us get rid of it and wear instead a shirt of selected colour; others would have a coat, but of a new cut, yet others would patch and extend the old, or at best not change the style. It does not matter a great deal which plan is followed, if it be followed wisely. What does matter is that we should not say we will starve ourselves, and bant ourselves, or let our figures "flop," and our faces drop, so that we may once more fit garments that were the right size for us before we began to grow. Who knows what privileges and advantages, and benefits, we may miss if we try to stop the progress of science and technology? Are we to be so arrogant as to say "to that stage of perfection we have come from which it is folly to advance further?" Heaven forbid. Let us progress. Let us develop new and better machines, let us investigate and re-investigate physical laws, let us winnow them for useful revelations, let us push on with chemistry seeking ever for new ways in which it may serve us; let us do nothing to stay the wheel of knowledge or to limit the gamut of our resources. To do else is to tie our talents in a napkin. But let us at the same time seek studiously for the means of deriving all the benefits from our amenities whilst cleansing them of their demerits. There is work there for the engineer as much as for the sociologist.

We print on another page an article called "Seven Cardinal Fallacies," by permission of

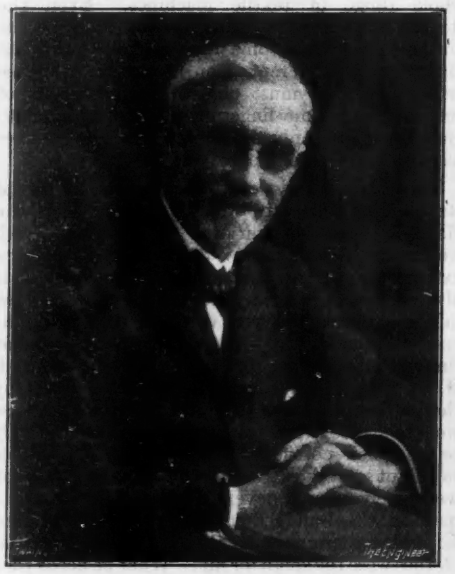
the Editor of *The Economist*. The author of this essay discusses with much liveliness and effectiveness the criticisms of the present age which are to be found in many daily papers, and in one weekly which entertains an author whose sub-acidity is tempered by disarming wit. We commend the article to the attention of all those who believe that the present state of the world is worse than it has ever been, and that the man of science, the man of technology, and the machine are the villains of the piece.

Obituary.

TOM WESTGARTH.

As recorded in last week's issue, the death took place on Tuesday, January 30th, at his home at Hassle, near Hull, of Mr. Tom Westgarth, who was until quite recently a director of Richardsons, Westgarth and Co., Ltd., Hartlepool.

Mr. Westgarth was in his eighty-second year, and for over half a century he had been a leading figure in engineering circles on Tees-side. He was born near Staithes, on the Yorkshire coast, and served his apprenticeship with C. and W. Earle, Hull. In that yard he worked in the drawing-office with the late Mr. A. E. Seaton, who later edited the well-known marine engineers' pocket-book, and he rose to be chief draughtsman and assistant works manager. In 1881 Mr. Westgarth founded with Mr. Harold English the marine engineering works of Westgarth, English and Co., at Middlesbrough. This firm became Sir Christopher Furness, Westgarth and Co., Ltd., in 1896, and acquired the old-established works of the Tees-side Engine Works Company, of Middlesbrough, including a riverside



TOM WESTGARTH

property, and besides developing and extending the marine business of the old firm, created a very important business in land engineering work. This included the manufacture of vertical rolling mill engines up to 20,000 H.P., tilting steel furnaces and metal mixers, water-tube boilers, condensing plants, &c. In 1900 Sir Christopher Furness, Westgarth and Co., Ltd., amalgamated with Thomas Richardson and Sons, Ltd., Hartlepool, and William Allan and Co., Ltd., Sunderland, to form the present company, of which Mr. Westgarth was originally a managing director jointly with the late Mr. D. B. Morison.

When the great works of the Cargo Fleet Iron Co., Ltd., were laid out at Middlesbrough, a contract was undertaken and successfully carried out by Furness, Westgarth and Co., Ltd., for the whole plant, including buildings, rolling mills, engines and boilers, gas-cleaning apparatus, &c. The chief feature of these works was the introduction upon a large scale of engines for blowing the blast-furnaces and driving dynamos by the use of the surplus gases from the blast-furnaces and coke ovens, gas cylinders of 51½in. diameter being used. This bold step was carried out by Mr. Westgarth under the patents of the Belgian firm of John Cockerill and Co., and led to great developments in the use of waste gases in Great Britain. Mr. Westgarth resigned the office of managing director in 1912, but remained on the board, and was chairman of the company in 1925–26, and then after a short interval continued to be a director to within a few months of his death. He was also a director of the Marine Oil Engine Development Syndicate, Ltd., the Iron Trades Employers' Insurance Association, Ltd., London, and Steel Developments, Ltd., Middlesbrough. During and after the War he was for three years Honorary Chief Inspector of Inland Engine Shops under the Controller General of Merchant Shipbuilding.

In addition to possessing a wide practical experience of the marine side of the engineering business, Mr. Westgarth was a recognised authority on steel works and rolling mill plant, in which the Middlesbrough works of Richardsons, Westgarth in the years before the war did considerable business. He was also, as far back as 1912, closely associated with the design and construction of a two-stroke single-acting marine oil engine, in conjunction with Carel Freres, of Ghent, and he took a real interest in the later design by Mr. W. S. Burn of the Richardsons, Westgarth all-British oil engine and its development. During the early years of the war he took an active part in organising a shell factory at Middlesbrough. He was President of the North-East Coast Institution of Engineers and Shipbuilders during the 1924–25 session, and was elected a Fellow of the Institution. He was a Past President of the Cleveland Technical Institute; a member of the Institution of Naval Architects, and a member of the Institution of Mechanical Engineers. He took a keen interest in local urban council affairs and some national charities.

Mr. Westgarth was a man of generous sympathies, a considerate employer, and always ready to assist those of his friends or former employees who had met with misfortune. There is no one who had the pleasure to be acquainted with him who will not feel a personal loss by his death. An extraordinarily gentle man, he was one of those who seemed to radiate sympathy and kindness to all around him. His knowledge of certain branches of mechanical engineering was profound, but he used that knowledge without a trace of arrogance, and the very mildness and quietness with which he put his views forward seemed to make them thrice effective. He was a firm upholder of the epigram that "more is to be learnt from failure than success," and when visiting works always made an endeavour to see the scrap heap. To be with him on these occasions was a privilege cherished by young men. The term "white man" has come to mean in English something too deep-seated to be expressed more clearly by a diffident nation, but if ever an engineer deserved that epithet in all its fullness, it was Tom Westgarth.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

STEEL COACHES: ELECTRICAL COOKING.

SIR,—The publicity recently given to these subjects is chiefly noticeable for confused thinking by the lay public, which is not entirely its fault. The public is anxious for the adoption of a form of construction which will minimise danger to life in the event of accident, and the lay Press throws steel coaches at its head without definition, but with the assumption that a coach is either all-steel or all-wood. The public should be allowed to know that in the strong steel underframe (with, if corridor, automatic couplings and spring-loaded vestibules), in conjunction with wood bodies, the best British construction combines the strength of steel to resist collapse with the easy rescue facilities of wood. There is, I believe, no known case of telescoping with this construction, and close-coupled articulated stock has proved to have similar characteristics.

Its author must by now regret the oft-quoted statement that cooking by electricity is impossible on the L.M.S. Stated thus baldly, the only comment would be that Mr. Lemon was seriously misinformed. Probably, however, what he intended to convey was that there were good reasons against the adoption by the L.M.S. of the L.N.E.R. practice. Two of these are not far to seek:—

(1) The disinclination of L.M.S. locomotives to supply the extra power called for.

(2) The time lag which occurs in this country before the adoption by one line of an idea which has first occurred to another.

The "Royal Scot" train for its American tour was, however, fitted with electrical cooking by means of current supplied by oil-driven generators. The L.M.S. have also followed the L.N.E.R. in the use of three-cylinder simple locomotives and the adoption of the "Pacific" type, and are now applying G.W.R. practice in the matter of boiler and "front-end" design.

It is therefore possible that the next thirty years may see the general adoption of electrical cooking, automatic couplings, with Pullman type vestibules, and, in another branch, 90ft. rails and two bolt fish-plates—in all which the L.N.E.R. has at present a lead.

L. A. F.

London, N.20, February 5th.

DEVELOPMENT OF THE PARSONS STEAM TURBINE.

SIR,—Following my letter of January 23rd on the Parsons steam turbine, it may interest you to have at first hand some further notes concerning the early days of steam turbines at the Metropolitan Electric Supply Company's station. I very gladly tell you what I know.

I joined the company in or about October, 1896, and for

TEMPORARY SWITCHBOARD AT MANCHESTER-SQUARE

the first eight weeks or so I was at Rathbone-place, which had Willans sets. I was then transferred to Manchester-square, where the first four Parsons turbo sets were already on load and a few Willans sets were yet remaining. Shortly after my arrival there the Willans were scrapped and two or three more turbines were put in. I am quite definite that during the time I was there all the sets had mechanical lubrication worked from the centre coupling worm gear, which also operated the intermittent relay steam control. All these sets were alike in details and had no signs of alterations or afterthoughts.

My most vivid recollections of Manchester-square are:—

(*a*) The interminable trouble of balancing. The turbines were not too bad, but the armatures were awful. Their critical speed was about half the running speed and we had to warm up and then jerk the revolutions up as quickly as possible, otherwise the set started walking down the engine-room.

(*b*) Rewinding armatures. In one case this took over

two years and we never got it to run decently. The armature conductors were silk insulated, tunnel-wound in holes punched in the laminations. The conductors were flexible and in one length, and in order to wind eight turns per pole some of the cable had to go eight times 6ft. in its journey through the armature holes. So earths were frequent, generally on the last lap. As the cable had some necessary clearance in the punched laminations, it was always loose and when under load it moved about, thereby upsetting all our efforts of balance. We had no balancing devices other than running the machines under steam.

(*c*) Hot bearings. These were cured (!) by shifting one or more of the pole pieces apart. This was done by inserting bits of key steel between one or two of the yokes. In some cases the magnetic field had ¼in. air gaps in the iron circuit.

(*d*) Back pressure under full load up to 20 lb. in the exhaust main was registered.

(*e*) Shortage of boiler power. With forced draught we usually had a plume of flame 20ft. long on the top of our chimney shaft, much to the consternation of the local householders.

(*f*) Our bottom row of boiler tubes was generally bunged up solid.

(*g*) Our switchboard fire. This brought the roof down, and all but two of the sets were damaged and could not be run. I enclose photographs of the temporary switchgear, which was made up of anything handy and would shame Heath Robinson. We had no voltmeters or ammeters in circuit. As the alternators could not then be paralleled we had to change over by slackening the cable thimbles and we broke the circuits under load by means of a snatch on a rope. We did not bother too much about putting all the lights out then in the West End several times a day in order to change over. The photographs show the temporary switchboard with feeders from Amberley-road, Rathbone-place, and Deptford.

(*h*) While I was there we had the exciting job of running the first revolving stage at Drury-lane for a play called "The Derby Winner," when the stage revolved at the same pace as the horses galloped. This job called for great care at M.S. This load frequently shut down other theatres, but we got lots of free tickets as a reward.

(*i*) During my time there Hiram Maxim carried out his experiments of making diamonds with electrodes in crucibles under pressure. We rigged up a bank of transformers on the premises and allocated a full turbo set for him. He worked this at night when the load was off. I helped him in many ways, but I never saw a diamond.

We had no telephones then and all communication with the other stations of the company was by the old Post Office A.B.C. instrument. It was all good fun and very interesting.

What surprises me now was the extraordinary ignorance of everyone, including myself, on the job. We had no unit meters and our log was taken once every hour from the ammeters only.

Dr. Pearce was with us at Manchester-square once for about a month and will remember what I write.

W. A. TRITTON.

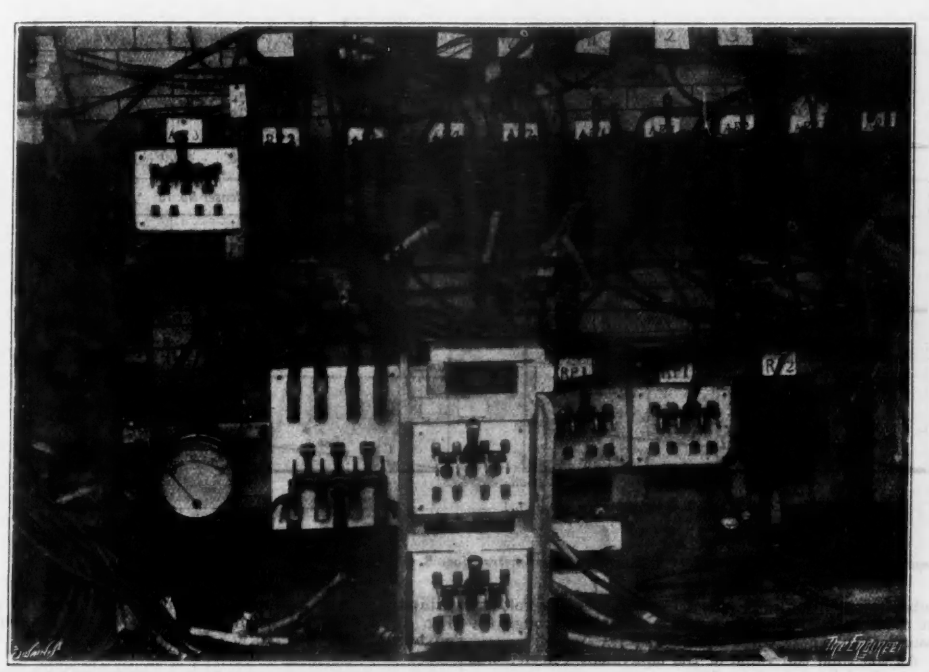
December 18th.

SIR,—So far as I am aware, the first sea-going Parsons turbo-generator was supplied to the Admiralty and fitted in H.M.S. "Camperdown" in 1889. I had charge of this machine, which afforded some interesting experiences.

When crossing the Bay of Biscay on the first voyage severe pitching occurred. The axis of the turbine was fore and aft, and end movement of the shaft resulted in many blades being stripped. As it required the full available boiler pressure to give the specified electrical output, with all blading intact, it was only possible to carry about half-load, after removing a bucketful of blades. New blade rings were sent out to the ship. These were shaped and fitted by the ship's artificers. It was found that the output after repair was not less than when the machine was new. This is a testimony to the skill and care of the artificers.

The dynamo, which ran at 8000 r.p.m., had a long commutator of small diameter, with, if my recollection is correct, fifteen segments to the circle for 80 volts. The brushes were formed of bundles of brass wire. Sparking was excessive, and the wear of brushes great. Although each brush was about 12in. long, it would not last for many hours.

We found that if a steady stream of oil was run on to the commutator, sparking ceased and brush wear was very small. A long bag of fearnought was suspended above the commutator, with which it was nearly in contact. The bag was filled with oil, which filtered through on to the commutator.



TEMPORARY SWITCHBOARD AT MANCHESTER-SQUARE

I fancy that this was a very early example of an oil break switch. In later machines Parsons commutators for D.C. machines were made of "ridge and furrow" outline, in order to increase the area for collection of current, without increase in length. I do not know if this was successful.

In the case of alternators, there would be no commutator troubles.

C. W. BRYANT.

Peterborough, February 6th.

RAILWAY BUFFERS.

SIR,—The accident which occurred last September at Bowling Basin, London and North-Eastern Railway, brings rather prominently to attention the matter of the best possible arrangement for the contacting surfaces of the buffing arrangements between railway vehicles.

The occurrence in question demonstrated remarkable immunity from telescoping of vehicles—and apparently even serious over-riding of buffers—notwithstanding the high speed at which the collision occurred and the weight of the vehicles involved in the train, which was brought to rest by the impact; the report states that the buffer heads were about 1ft. 6in. diameter and on all except two vehicles which had "flat" type faces—by which presumably is meant the usual slightly convex British type—the faces of the buffers were alternately convex and concave fitting into one another when coupled.

Experience on certain railways where relatively severe curvature existed in combination with side buffers on the rolling stock, which side buffers were of the usual English slightly convex type, convinces me that the said common type is about the most unsatisfactory of any of the side-buffer arrangements. In the case of collision, which always involves the tendency to tip the ends of vehicles either up or down, the common form of buffer face lends itself to telescoping of the vehicles, whilst on lines of a curved nature complicated by trains having long double-bogie stock mixed in with short four-wheeled stock producing a large amount of lateral discrepancy between the buffer centres, the common form of buffer face tends to allow buffer locking when brake applications and shunting movements are taking place.

On railways in Europe generally the standard buffer faces are alternately flat and convex, the right-hand buffer facing outwards from a vehicle always being the convex one and the left a flat one; hence a convex and flat face always met in service. Unquestionably this seems a better arrangement than the two convex faces of general British practice.

In the report of the Bowling Basin accident it does not seem clear whether the concave faces were really concave faces to spring buffers or whether they were a species of dummy buffers of concave form. Years ago the suburban passenger trains of the Midland and other companies operating close-coupled set trains in the London district were equipped with one buffer of practically normal British type working against a slightly concave face in a dummy buffer opposite. It may be that those in the Bowling Basin accident were of a similar type.

It seems that to best meet most of the practical considerations the arrangement should be one buffer face slightly concave and the other convex to a somewhat greater extent; also there is much to be said for the "sleeve" form of buffer plunger, as not so readily bent up or down in a collision as are the spindle type plungers normally used on carriage and wagon stock.

It would appear that perhaps railway engineers have gone ahead with what at first sight and in the early days must have appeared to be the most obvious form of buffer face, without reference to what might be the most perfect form available. Perhaps this letter may induce some expression of opinion on the subject.

P. C. DEWHURST.

Montevideo, January 11th.

COMBUSTION CONTROL.

SIR,—I have read your Leader on Combustion Control in the issue of February 2nd with great interest, but feel that there is likely to be a misunderstanding as regards some of the figures which I quoted at last Friday's meeting at the Institution of Mechanical Engineers. The figures given by me are savings effected by automatic combustion control expressed as percentages of total fuel bills for the plants mentioned, but they do not represent any increase in station thermal efficiencies.

It obviously will lead to confusion if a common basis is not agreed upon on which to estimate any beneficial results from a combustion control system, and I believe it is best to refer to the overall station fuel rate rather than boiler efficiency, as there are some savings which combustion control can effect which are not reflected in boiler efficiencies.

In quoting savings expressed as a percentage of the total fuel bill in this way a figure is immediately obtained which has a direct bearing on the capital cost of any particular system, and which will give the engineer responsible the best view he can have of the commercial results of installing a combustion control system. Combustion control has, of course, several advantages which result in overall savings, all of which can be expressed in terms of fuel if so desired, but the figures to which I referred apply to direct fuel savings only.

F. L. CATER.

London, February 5th.

BOOKS RECEIVED.

The "Motor Ship" Reference Book for 1934. London: Temple Press, Ltd., 5–15, Rosbery-avenue, E.C.1. Price 5s. net.

The Electromagnetic Field. By H. F. Biggs, M.A., M.Sc. London: Oxford University Press, Amen House, Warwick-square, E.C.4. Price 10s. 6d. net.

Notebook of Mathematics. By G. T. H. Cook, B.Sc. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 2s. 6d. net.

Reinforced Concrete Arch Design. By G. P. Manning. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 12s. 6d. net.

Planning, Estimating, and Ratefixing. By A. C. Whitehead. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 10s. 6d. net.

Das Getreidekorn. Vol. II., *Die Getreidespeicher.* Dr. J. F. Hoffmann, revised by Prof.-Dr. K. Mohs. Berlin: Verlag Paul Parey, Hedemannstr. 28–29, S.W.11. Price 27 marks.

Industrial Accountancy, with Special Reference to the Steel Trade. By H. A. Simpson. London: Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C.4. Price 10s. 6d. net.

A Hundred Years of Towage: A History of Messrs. William Watkins, Ltd., 1833–1933. By F. C. Bowen. Gravesend: *Gravesend and Dartford Reporter*, Harmer-street. Price 5s. net.

First Year Engineering Science: Mechanical and Electrical. By G. W. Bird, Wh.Ex., B.Sc., &c. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 5s. net.

Brassey's Naval and Shipping Annual, 1934. Edited by Commander C. N. Robinson, R.N., and H. M. Ross London: William Clowes and Sons, Ltd., 94, Jermyn-street, S.W.1. Price 25s. net.

Tests on Structural Models of Proposed San Francisco-Oakland Suspension Bridge. By G. E. Beggs, R. E. Davis, and H. E. Davis. London: Cambridge University Press, Fetter-lane, E.C.4. Price 7s. net.

Industrial Heat Transfer. By Dr.-Ing. A. Schack. Translated by Dr.-Ing. H. Goldschmidt and E. P. Partridge, Ph.D. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 31s. net.

South and East African Year Book and Guide for 1934. Edited by A. Samler Brown, F.R. Met. S., and G. Gordon Brown, F.R.G.S. London: Union Castle Mail Steamship Company, Ltd., 3, Fenchurch-street, E.C.3. Price 2s. 6d. net.

Forschungsarbeiten über Metallkund und Röntgenmetallographie. Folge 10: Gufzeisen-Gefugelehre. By M. F. o. Schwarz. Munich: Verlag Fritz and Jos. Voglrieder, Hermann Linggstrasse 12, 2 S.W. Price 9 marks.

The Design of Surface Condensing Plant*

No. I.

By H. L. GUY and E. V. WINSTANLEY, B.Sc. (Tech.)

Introduction.

THE progressive increase in the size of power plant units during the last twenty years has introduced new considerations in the design of condensing plant, necessitating not only reconsideration of the accepted methods of approach to the design of condensers, but also the introduction of fresh factors and a new conception of what actually takes place in the condenser.

The gradual increase in size of plant was a world-wide movement, and the first large growth in size of condensers, accompanied as it was by the development of the technique and practice of accurate testing, disclosed many cases of disappointing results. The apparent rate of heat transmission deduced by the method then employed by condenser designers appeared to be alarmingly less than had been obtained in smaller condensers.

In various parts of the world it was found that in large plants the actual vacuum was from ½in. to ¾in. worse than could be reasonably expected.

It must be remembered that between 28in. and 29in. of vacuum, ½in. of vacuum corresponds to a difference of approximately 2½ to 3 per cent. in steam consumption, so that the financial loss (on important plant) was considerable.

In many instances it was found that the vacuum in a particular condenser could be materially improved by removing 20 to 30 per cent. of the tubes.

In the authors' experience, the phenomena which caused the very heavy loss of vacuum just referred to did not result in equally large increase in steam consumption, partly because in this country the absolute change in dimensions was not as great as in some others, and partly because the allowance for air withdrawal from condensers adopted in this country was much more generous than abroad.

Further, the air pump then being used responded admirably to very low pressure air extraction.

For these reasons in bad cases the deficiency in vacuum at the exhaust flange was, say, 0·2in. instead of 0·5in., because the air pump was able to maintain 0·3in. higher vacuum at the bottom of the condenser than was intended in the original design.

Pressure Drop in Condensers.

Careful measurement clearly revealed that in all cases where the actual vacuum was disappointing there was a considerable drop of steam pressure in passing across the tubes, and a number of investigations suggested certain dimensional factors which might control its magnitude.

Further, a simple mathematical investigation suggested the way in which these dimensional factors might be expected to be co-ordinated.

A number of condensers were then selected, varying sufficiently in properties to provide a reasonable test of the hypothesis which had been built up, and the careful observations recorded on Fig. 1 were made.

These investigations started from the expectation that the drop in pressure $\delta\rho$ would depend not only on the square of the velocity of the steam between the tubes and upon the density of the steam, but also upon the number of tubes crossed before condensation was complete. For the types of condensers with which the authors were working the number of tubes crossed might reasonably be represented by the diameter D of the nest tubes.

Then it would be expected that $\delta\rho = (C\,D)\,\frac{U_E^2}{V}$, in which U_E is some equivalent or average velocity between the tubes representing in its effect the very varying velocity at different points in the passage of steam through the complete tube nest, while C is a constant.

At the time the value of the equivalent velocity was determined from the formulæ

$$U_E = \frac{Q\,V}{L\,.\,D\left(1 - \frac{d}{p}\sqrt{\eta_{TP}}\right)} \text{ foot-seconds} \quad . \quad . \quad . \quad (1)$$

Where Q = Steam to condenser in pounds per second.

V = Specific volume in cubic feet per pound, corresponding to the vacuum at inlet to the condenser.

L = Length of tubes between tube plate in feet.

D = Diameter of tube nest of condenser in feet.

d = Outside diameter of tube in inches.

p = Mean pitch of tubes in inches.

η_{TP} = Tube plate efficiency

$$= \frac{\text{(Actual No. of tubes in tube plate)}}{\text{(No. possible with mean tube pitch)}}$$

It is important to observe that it is the diameter of the bundle of tubes constituting the tube nest which is involved in determining U_E, and not the diameter of the condenser shell.

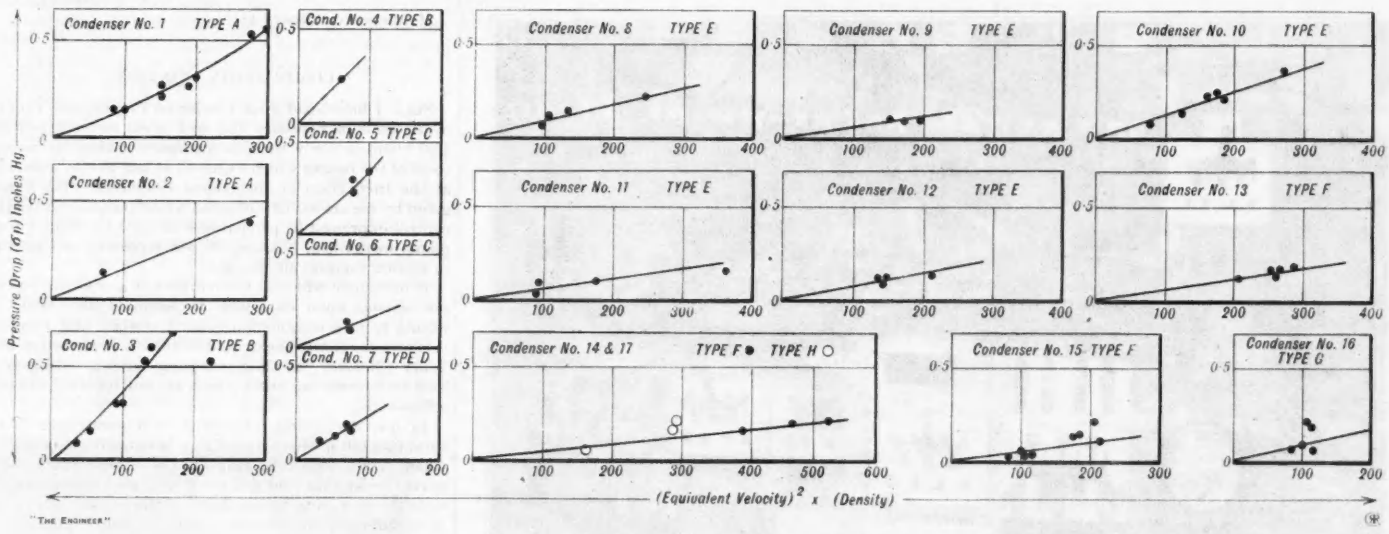

Condenser No. 1 TYPE A
Cond. No. 4 TYPE B
Condenser No. 8 TYPE E
Condenser No. 9 TYPE E
Condenser No. 10 TYPE E
Condenser No. 2 TYPE A
Cond. No. 5 TYPE C
Condenser No. 11 TYPE E
Condenser No. 12 TYPE E
Condenser No. 13 TYPE F
Cond. No. 3 TYPE B
Cond. No. 6 TYPE C
Condenser No. 14 & 17 TYPE F● TYPE H○
Condenser No. 15 TYPE F
Condenser No. 16 TYPE G
Cond. No. 7 TYPE D
Pressure Drop (δρ) Inches Hg.
(Equivalent Velocity)² x (Density)
"THE ENGINEER"

FIG. 1—*Pressure Drop Characteristics; Condensers Nos. 1 to 7 Downflow, Condensers Nos. 8 to 16 Central Flow.*

exhibited in the examples, condensers Nos. 8 to 12 of Fig. 1, and it will be observed, this represents some advance.

TABLE I.

Condenser No.	Type.	Surface. sq. ft.	Length of condenser, ft. in.	Diam. of condenser, ft. in.	Tube plate effy. per cent.	C = Slope of graph / Diam. of cond.
1	A	26,000	18 0	11 0	73·2	0·000155
2	A	25,000	18 0	11 0	70·3	0·000155
3	B	23,500	16 0	9 9	80·8	0·00041
4	B	8,200	14 6	6 3	66·2	0·00064
5	C	20,500	15 0	9 9	75·2	0·00034
6	C	7,100	14 0	5 9	73·5	0·000278
7	D	8,250	14 6	6 3	72·5	0·000368
8	E	15,500	14 6	8 9	69·4	0·000101
9	E	10,400	13 6	7 0	78·1	0·0000765
10	E	37,800	20 6	11 0	75·5	0·000118
11	E	18,000	16 6	8 9	70·7	0·000085
12	E	13,250	14 6	7 9	75·9	0·000107
13	F	11,380	14 6	7 9	64·5	0·000074
14	F	42,200	23 0	12 6	65·5	0·000032
15	F	19,100	18 0	9 9	55·0	0·000059
16	G	16,600	16 0	9 9	67·5	0·000093
17	H	40,300	22 0	12 6	64·5	0·000032

In a later development, when radial pitching of the tubes was substituted for triangular pitching in the outer rows, the criterion C was further reduced, as will be apparent from the tests on condensers 13, 14, and 15 of Type F in Fig. 1.

Types G and H are still later developments showing the same characteristic difference with regard to design for pressure drop as distinguishes E from F. The pressure drop criterion C for the final designs is about ten times better than that obtained when these investigations were commenced.

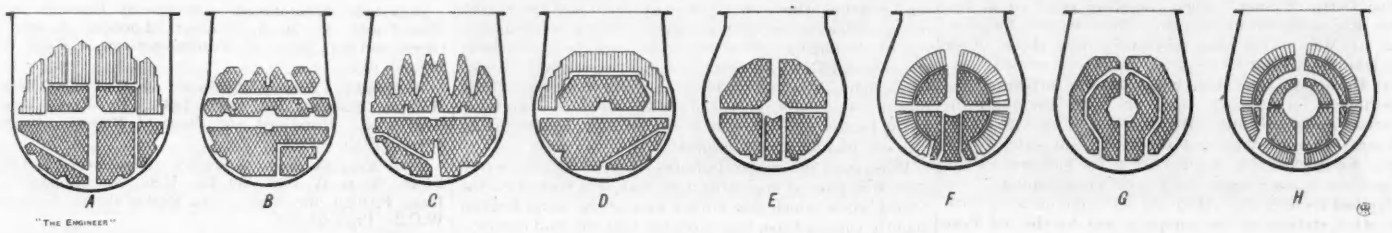


FIG. 2—*Types of Condenser Tube Plates.*

For the same tube plate efficiency the tubes may be disposed in a large variety of ways, and the examples selected for Fig. 1 cover a reasonable range of the patterns with which the authors had experience. These types are illustrated in Fig. 2 and figures are given in Table I.

Thus between the condensers No. 4 and No. 7, which are in the same diameter shell, the tube plate of the latter is 9 per cent. more crowded than the former, but for the same equivalent velocity the latter arrangement is nearly twice as effective for the passage of steam.

The characteristic difference between these two cases lies in the triangular tube pitching with tube lanes of the No. 4 condenser, compared with the use of vertical pitching without lanes in condensers of the type of No. 7.

On the other hand, in a shell of the same diameter the type of steam lane was substantially different in the cases of the No. 3 and No. 5 condensers, but without any marked change in resistance to flow of steam.

Although there is a substantial variation in the value of C, deduced from the tests of the different types, it has been found during a period of over ten years that the pressure drop can be predicted with sufficient accuracy for any particular type by selecting the value of C from tests of the character shown in Fig. 1 for the type which most closely matches the actual tube plate lay-out.

The authors would point out that the results published in this paper present a characteristic selection only, it being impracticable to incorporate the whole of the results on which their conclusions are based.

When the type of design of condenser is materially different from that on which these observations have been made, the same method of estimating $\delta\rho$ can be used, providing the value of C is deduced from a careful test of a design of that type.

One of the first steps taken to control and reduce the pressure drop was the replacement of the older down flow type of condenser dealt with in Fig. 1 by a central flow condenser in which steam is given access to the whole periphery of the tube nest by the provision of a volute enclosing the nest, all steam lanes being eliminated.

Characteristic results obtained with this type are

Effect of Pressure Drop on Surface Required.

Directly the presence of the pressure drop in the steam side of the tube nest was appreciated, and its magnitude known, it became necessary to examine how it influenced the exchange of heat across tubes in different parts of the tube nest.

The heat transmission in a condenser is obtained from the formulæ

$$K = \frac{S \times h_o}{t_m \times \Sigma} \text{ B.Th.U./1 deg. Fah./square foot/hour} \quad . \quad (2)$$

* Read before the Institution of Mechanical Engineers, North-Western Branch, on February 1st, 1934.

Where S = Total weight of steam to condenser in pounds per hour.

h_c = Heat abstracted in condenser, B.Th.U. per pound = $h_2 - h_4$.

h_2 = Total heat per pound of steam at entrance to condenser, B.Th.U. per pound.

h_4 = Sensible heat of condensate, B.Th.U. per pound.

Σ = Total surface of condenser in square feet.

t_m = Mean temperature difference causing heat flow across surface, degree Fah.

The well-known formulæ due to Grashof for contraflow conditions gives

$$t_m = \frac{(t_4 - t_1) - (t_3 - t_2)}{\log_e \frac{(t_4 - t_1)}{(t_3 - t_2)}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The symbols in this formula have the significance shown in Fig. 3, Case A. At the time referred to a simplification of this formula was almost invariably used in condenser work and was obtained by assuming that the steam temperature on the steam side of the condenser was constant, so that t_4, the temperature at the bottom of the condenser, became equal to t_3, the temperature at the top, formulæ (3) then taking the usual form

$$t_m = \frac{t_2 - t_1}{\log_e \frac{(t_3 - t_1)}{(t_3 - t_2)}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The assumption that the steam temperature is constant is valid only if there is no pressure drop through the tube nest, so both these formulæ must be examined with respect not only to pressure drop, but also to any other departures from the conditions controlling the temperature gradient in a condenser assumed by Grashof in deducing them. In order to illustrate how the actual conditions in a condenser depart from the theoretical case assumed by Grashof, Fig. 3 was prepared for a condenser maintaining a vacuum of 27·8in. Hg. with 80 deg. Fah. inlet and 93 deg. Fah. outlet water temperature and a pressure drop of 0·4in. Hg.

Fig. 3, Case A, illustrates Grashof's assumption of contraflow heat exchange with the further usual and implied assumption that these conditions apply equally to each and every tube in the condenser. The distribution of temperature gradient obtained in this way is shown in the area shaded vertically. The effect of the further assumption which produces formulæ 4 is shown by the diagonally shaded area of Fig. 3, Case A, obviously leading to an apparently increased mean temperature difference.

Now, in an actual condenser the flow of steam is across each row of tubes at right angles to the direction of the water flow inside the tube, and while the temperature on the steam side of each tube is constant for the whole length of that tube, if there is a drop in pressure as the steam passes through the tube nest the steam temperature is progressively falling from one row of tubes to the next in the direction of steam flow.

Consequently, the rise in the water temperature in successive rows of tubes is different and gets progressively less as one passes from one tube row to another in the direction of steam flow. The water is, therefore, leaving the tubes at different temperatures, and it is the temperature after mixing which is the t_4 of Grashof's formulæ.

The heat exchange in condensers is, therefore, of the crossflow type, shown diagrammatically in Case B, Fig. 3, for a single pass condenser, and is distinctly not of the contraflow type.

The temperature gradients plotted for crossflow cases were obtained by an analysis due to Dr. D. M. Smith, based on assumptions which closely resemble the conditions actually occurring in a condenser. For the single-pass arrangement, illustrated in Case B, Fig. 3, this analysis gives :—

$$t_m = \frac{t_2 - t_1}{\log_e \left[\frac{1}{1 - \left(\frac{t_2 - t_1}{t_3 - t_4} \right) \log_e \left(\frac{t_3 - t_1}{t_4 - t_1} \right)} \right]} \quad . \quad . \quad (5)$$

The temperature gradients for the middle row of tubes

values of δp by Grashof's two formulæ and by extending it to the two-pass case on the assumption that the temperature entering the second pass is the arithmetic mean of t_1 and t_2. The further assumption has also been made that the mean steam temperature half-way down the condenser is the arithmetic mean of that at the top and bottom.

While, on theoretical grounds these assumptions might be questioned, they are reasonably consistent with observations made on actual condensers.

Grashof's formula for the two-pass case then becomes :

$$t_m = \frac{1}{2} \left\{ \frac{(t_4 - t_1) - (t_i - t_r)}{\log_e \frac{(t_4 - t_1)}{(t_i - t_r)}} \right\} + \frac{1}{2} \left\{ \frac{(t_i - t_r) - (t_3 - t_2)}{\log_e \frac{(t_i - t_r)}{(t_3 - t_2)}} \right\} \quad . \quad (6)$$

where t_1, t_2, t_3, and t_4 have the significance previously defined, t_i is the arithmetic mean steam temperature between the top and bottom of the condenser, and t_r is the water temperature at the reverse end water box. This is Case 4 of Table II.

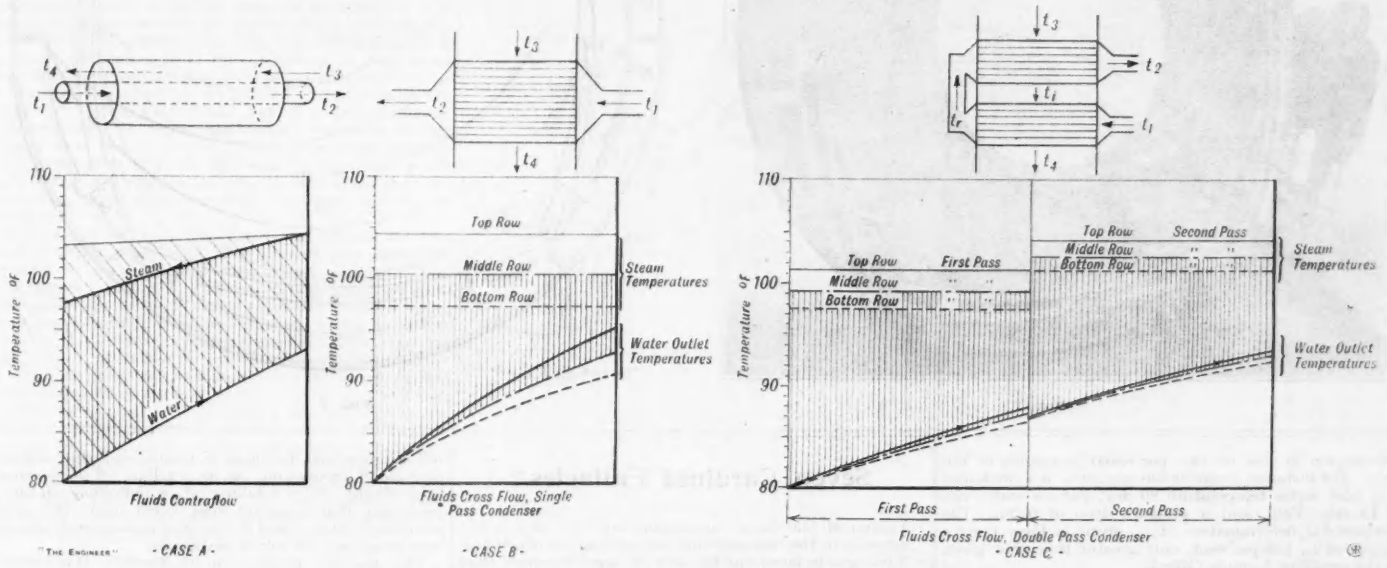


FIG. 3—*Temperature Gradients for Different Assumptions of Fluid Flow in Condensers.*

The corresponding three crossflow cases have been added from Dr. D. M. Smith's analysis as defined in Cases 3, 5, and 6 in Table II. The simple arithmetic temperature difference has been given in Case 7, and applies equally to single or double-pass condensers. Table II. covers the economic vacuum for industrial plant and in power stations other than those intended to operate at very high load factors. The important criterion represented by the difference between the vacuum temperature and that of the inlet circulating water ($t_3 - t_1$) is 23 deg. to 24 deg. Fah.

It should be explained that where dashes occur instead of figures in Table II., the conditions assumed for that case cannot be fulfilled, the value of t_m becoming impossible.

TABLE II.—*The Effect of Pressure Drop Through a Condenser Upon the Mean Temperature Difference. Saturation Temperatures from Callendar, 1931, Tables.*

Case (1) $t_m = \frac{(t_4 - t_1) - (t_3 - t_2)}{\log_e \frac{t_4 - t_1}{t_3 - t_2}}$.

Case (2) $t_m = \frac{t_2 - t_1}{\log_e \frac{t_3 - t_1}{t_3 - t_2}}$

Case (3) Cross flow for single pass (Formula 5).
Case (4) Grashof two pass with equal water temperature rise in each pass (Formula 6).
Case (5) Cross flow for two pass with equal water temperature rise in each pass.
Case (6) Cross flow with calculated temperature at inlet return flow and constant coefficient of heat transmission.
Case (7) Arithmetic mean temperature difference, $t_m = \frac{(t_4 - t_1) + (t_3 - t_2)}{2}$.

$t_2 - t_1$.		16 deg. Fah.							13 deg. Fah.							10 deg. Fah.						
	" Hg.	One pass.			Two pass.				One pass.			Two pass.				One pass.			Two pass.			
	δp	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
t_1 = 80° F.	0	14·80		14·80	15·79	15·79	14·79	16·20	16·90		16·90	17·48	17·48	16·90	17·70	18·75		18·75	19·09	19·09	18·75	19·20
Vacuum =	0·2	13·62		12·89	14·38	14·29	13·57	14·60	16·45		15·20	16·05	15·84	15·38	16·10	17·31		17·10	17·55	17·49	17·21	17·60
27·8" Hg.	0·4	12·27	14·80	10·8	12·67	12·40	11·82	12·85	14·18	16·90	13·20	14·34	13·99	13·92	14·35	15·87	18·75	15·02	15·77	15·64	15·55	15·85
$t_3 - t_1$ =	0·6	10·72		7·94	10·79	10·22	10·08	10·95	12·35		10·62	12·44	11·98	11·83	12·45	13·89		12·71	13·95	13·58	13·32	13·95
24·3° F.																						
t_1 = 70° F.	0	14·22		14·22	15·37	15·37	14·22	15·7	16·39		16·39	16·97	16·97	16·39	17·2	18·24		18·24	18·60	18·60	18·24	18·70
Vacuum =	0·2	12·78		11·85	13·32	13·12	12·39	13·55	14·50		13·97	14·94	14·77	14·42	15·05	16·30		15·90	16·39	16·40	16·18	16·55
28·4" Hg.	0·4	10·73	14·22	8·41	10·97	10·42	10·19	11·1	12·56	16·39	11·11	12·64	12·10	12·11	12·60	13·91	18·24	13·27	14·10	13·78	13·70	14·10
$t_3 - t_1$ =	0·6	8·30		—	8·29	7·26	7·09	8·30	9·70		6·39	9·72	9·05	8·79	9·80	10·99		9·02	11·30	10·75	10·40	11·30
23·7° F.																						
t_1 = 60° F.	0	13·69		13·69	14·93	14·93	13·69	15·20	15·85		15·85	16·50	16·50	15·85	16·70	17·82		17·82	18·10	18·10	17·82	18·20
Vacuum =	0·2	11·60		10·20	12·03	11·73	11·21	12·25	13·47		12·50	13·70	13·40	13·21	13·75	15·20		14·60	15·20	15·02	14·90	15·25
28·85" Hg.	0·4	8·61	13·69		8·59	7·78	7·72	8·70	10·22	15·85	7·64	10·20	9·56	9·52	10·20	11·60	17·82	10·0	11·75	11·24	11·15	11·70
$t_3 - t_1$ =	0·6	3·48		—	4·02	—	—	4·25	4·22		—	5·30	—	—	5·75	5·11		—	6·67	—	—	7·25
23·2° F.																						
t_1 = 50° F.	0	14·60		14·60	15·68	15·68	14·60	16·0	16·72		16·72	17·33	17·33	16·72	17·50	18·52		18·52	18·88	18·88	18·52	19·0
Vacuum =	0·2	11·51	14·60	9·60	11·96	11·52	11·08	12·05	13·42	16·72	12;01	13·54	13·07	12·89	13·55	15·02	18·52	14·05	15·12	14·75	14·70	15·05
29·15" Hg.	0·4	6·84		—	6·91	5·03	5·28	6·85	8·11		—	8·22	7·05	7·00	8·35	9·25		6·60	9·68	—	8·90	9·85
$t_3 - t_1$ =																						
24·0° F.																						

The deductions to be made from these figures are as follows :—

In the case of single-pass condensers, the crossflow analysis used in Case 3 most nearly represents the actual conditions, and gives a substantially different result from either of the more usually adopted Grashof formulæ.

It is possible that the apparently low rate of heat transmission which has been obtained occasionally on single-pass condensers arises not mainly from air blanketing, nor from lower rates of heat transmission in the condenser itself, but from the fact that the formula used to determine the mean temperature difference gave a value which was appreciably in error.

The nature of this discrepancy will be apparent by

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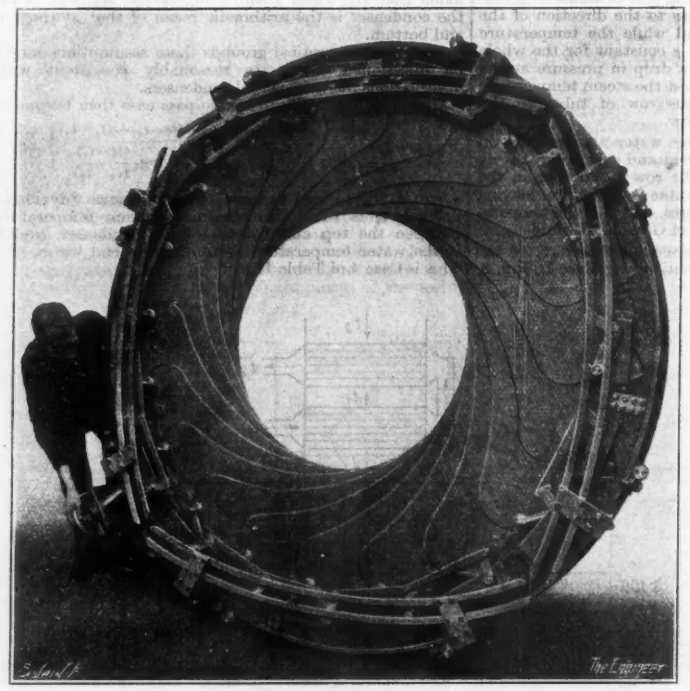


FIG. 1

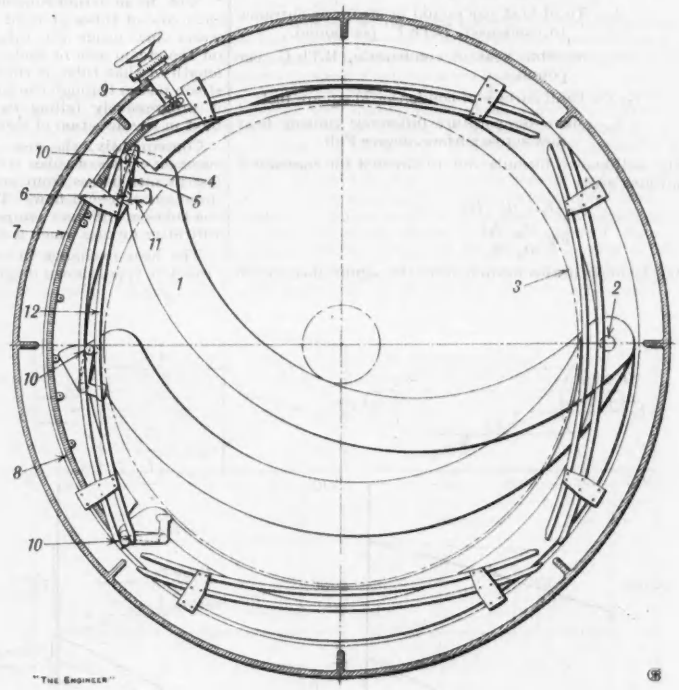


FIG. 2

examination of one or two particular examples in the table. For instance, consider the condition in a condenser with inlet water temperature 80 deg. Fah., a water rise of 13 deg. Fah., and a pressure drop of 0·2in. The conventional determination of t_m given in Case 1 gives a value of t_m 1·6 per cent. only greater than that given by the crossflow formula Case 3.

On the other hand, for the large pressure drop of 0·6in. the conventional t_m would be over 16 per cent. greater than the actual. At such water temperatures, therefore, unless considerable pressure drops are encountered, the discrepancy is not very great. If, however, colder water at 60 deg. inlet temperature is used in a single-pass condenser having a pressure drop of 0·2in., the conventional t_m given in Case 1 is 7·7 per cent. too great, while, if the pressure drop increased to 0·4in., the conventional mean temperature difference would be over 33 per cent. too large.

In this latter case, therefore, if the conventional formula of Case 1 were used to analyse a test, the value of the rate of heat transmission which would be deduced would probably be only 75 per cent. of the actual.

Alternatively, if rates of heat transmission obtained on small condensers are used as a basis in the design of large single-pass condensers with 60 deg. inlet water temperature and with a pressure difference of 0·4in., the surface which would be supplied would be over 50 per cent. too small.

For single-pass condensers, therefore, if serious errors are to be avoided, the Grashof formula, which has been used formerly, should be abandoned and the crossflow formula adopted.

The simplified formula of Case 2 should never be used for single-pass condensers.

When the case of double-pass condensers is examined it will be found that the change introduced by the return flow brings all the formulæ, including even the simple arithmetic mean, much more closely into line with one another than was the case for the single-pass condenser.

It can still be said that the Grashof simplified formula of Case 2 should never be used, because the even simpler formula of Case 7, giving the arithmetic mean, provides, on the whole, a much closer approximation to the truth.

Of the two crossflow Cases 5 and 6, Case 5, which assumes an equal temperature rise in the two passes, more closely approximates to the actual conditions than Case 6, which is based on the assumption of constant coefficient of heat transmission in the two passes.

Taking the set of conditions discussed for the single-pass condensers, in which the inlet water temperature was 60 deg., and the temperature rise 13 deg., with a pressure difference of 0·4in., it will be found for two-pass condensers that the difference of t_m between the Grashof formula, of Case 1, and the crossflow formula, of Case 5, is less than 7 per cent.

The authors feel, therefore, that in the case of two or three-pass condensers the conventional Grashof formula of Case 1 can be used without sensible error provided it is used both in the analysis of tests for the determination of rates of heat transmission and in design for the determination of surface on the basis of such rates of heat transmission.

It is not without interest to note by comparison of Cases 5 and 7 how closely in the case of two or three-pass condensers the simple arithmetic mean temperature difference would represent the probable conditions.

The appreciable difference in the mean temperature difference given in Case 3 for the single-pass condenser, as compared with Case 5 for the two-pass condenser, illustrates an inherent disadvantage of the former, compared with the latter design.

(To be continued.)

Seven Cardinal Fallacies.*

"ALMOST all the ills of the present world are due to the advance of the Internal-Combustion Engine, which produces goods more quickly and in larger amounts than people can possibly consume. It will take at least fifty years, with a corresponding increase of population, to consume the vast amounts of unwanted articles that the I.C.E. has dumped upon the world."—"A. A. B." in the *Evening Standard*.

Logic has its Six Cardinal Fallacies and Theology its Seven Deadly Sins. Surely Economics should be allowed a similar panel. The only reason, perhaps, why no specific economic delusions have so far attained canonisation is that there are unfortunately so many that it seems invidious to choose between them. Lately, however, seven of them have acquired such eminent popularity that they would appear to deserve the name of the Seven Cardinal Fallacies of Economics. All seven are contained or implied in the two admirably crisp and comprehensive sentences quoted above from the works of "A. A. B."

First and foremost, undoubtedly, in the hierarchy of Economic Error stands the Fallacy of Machines. This fallacy is really a Trinity, and each of its Members are many-headed as well. In controversy it is a sort of soldier of fortune; willing to do service alike for monetary cranks, theoretical Marxists and restrictionists like Mr. Elliot. In its simplest form, it states that mechanical or technological progress has been so rapid in recent years that the supply of goods produced exceeds the possibilities of consumption. The idea derives its plausibility from the coincidence to-day of rationalisation in particular industries and general over-production in relation to monetary demand. In its Primary Form, however, it neglects the elementary truths that human wants are infinite, that the economic process is a process of exchange, and that every commodity or service produced creates demand as well as supply. It also forgets that technological progress did not descend suddenly from heaven to earth in 1929, but has proceeded at varying speeds from the dawn of history. The cataclysmic succession of "The Age of Scarcity" by an "Age of Plenty."—another part of the Machine Myth—is unfortunately also a fiction; since in actual fact there has been a gradual, if periodically accelerated, mitigation of scarcity from the earliest times.

When this is recognised, the Machine Fallacy assumes its Secondary Form: that modern production has outrun, if not real demand, at least the effective demand made possible by the present (*a*) economic and/or (*b*) monetary system. Now it is undeniable that the immediate cause of depression and unemployment is a failure of consumers' money demand. But it is one thing to argue that the present monetary or economic system *may* generate a deficiency of consumers' purchasing power, and quite another thing to argue that it *must*. The first proposition is incontestable. The second is refuted by theory and practice alike. For it is obvious that, since all money costs are ultimately consumers' incomes, enough incomes are generated by the process of production itself to buy the commodities produced, so that if, as in normal conditions, all that is earned is either spent or invested, there will be no deficiency of purchasing power. It is also obvious that, in fact, such conditions *have* more often prevailed than not; since the general price level has not always, or even usually, been falling.

Even when this is understood, however, it is frequently forgotten that an increase in the total of goods produced, even though not balanced by an increased money supply, need not cause depression. Such an increase will cause a fall in prices per unit of goods produced, but not a fall in money (or real) profits, and consequently not a slackening of enterprise. A price fall due to increased production need not involve depression. It follows, of course, that a fall in prices that *does* lead to depression is due, not to an increase of production, but to a falling off of consumers' expenditure. Such a falling off or deficiency, in fact, is something that *may*, not *must*, occur under the present monetary system; and that system consequently stands in need of reform but not of revolution.

The Machine Fallacy, in its Tertiary Manifestation, maintains that, whatever the ultimate facts about demand, supply and money may be, mechanical development has made a large percentage of the world's labour permanently unwanted and superfluous. The mistake at the root of this argument is simple, though widespread. It consists of the assumption that a certain fixed volume of goods and services (apparently that produced in 1929) is sufficient for all the wants of all the human race. Mechanical progress since 1929 has certainly enabled us to produce this given volume of goods and services with a smaller quantity of labour. But it has also enabled us to produce a greater volume of goods and services with the same quantity of labour. Mechanical progress has made a general reduction of hours *possible*, but not *necessary*. The workers of the world now have it in their power to choose whether they would rather consume the same amount as before and work less, or work as much and consume more. If they would rather consume more, new industries or a greatly increased amount of personal services will develop and absorb the labour released from the old. In spite of the present cyclical disturbance they have begun to do so already, as all relevant statistics show.

It is largely the Fourth, or *Status Quo*, Fallacy that blinds people to the significance of new and growing industries. Sufferers from this very common delusion conceive of the wealth and productive capacity of a community, not as a flexible system of innumerable trades and industries, some expanding, some contracting, and all adjusting themselves to the ever-changing conditions of supply and demand, but as a definite set of specific, fixed industries. The average politician of to-day does not see it as his economic duty to direct all economic resources in the direction where they will satisfy the greatest demand, but rather to attempt to preserve the *status quo* of all existing industries. If there is a depression (the worshipper of the *status quo* believes), assist the steel industry, save agriculture; protect this and subsidise that; preserve the British railways, American farming, Italian glass blowing, or what you will, regardless of changes in demand and anything else whatever. By this Fallacy (out of Corruption) Protectionism is begotten in all its hideously Protean forms; as well as price-fixing, valorisation, subsidies, artificial restrictions of production, and all other expedients so far devised to prolong the agony of depression by keeping uneconomic industries unnaturally alive.

The Fifth, or Monetary Unit, Fallacy, really a bastard offspring of the Secondary Machine Fallacy, is more subtle than the rest. According to this dogma the number of monetary units issued should correspond to the "real wealth" of the community. This sometimes means that every monetary unit should be "based" on real fixed capital in the sense in which notes are, or are supposed to be, "based" on gold. But more often it means that the number of monetary units must be "equated" or "adjusted" to the volume of goods produced. Adherents of this dogma unhappily forget that two quantities cannot be equated or compared unless both can be measured on a common scale. You cannot "equate" the number of pounds (or dollars) issued with the number of tons of coal (or pints of milk) produced, because £1 does not *equal* one ton, or half a ton, or any other fraction or multiple of a ton. You can only establish a ratio between the two by allowing them to be priced in a market. And you can only do that if the number of monetary units being spent is *already given*. Without price there can be no comparison of money and goods; and without a given supply of money and goods there can be no price.

It was really to meet this latent difficulty that "technocracy" invented its system of "ergs." The ergs, or units of energy, used in the production of all commodities were

* From THE ECONOMIST, January 20th, 1934

to be calculated and a corresponding number of units issued as currency. Similarly, others have wished to equate the number of monetary units to the number of working hours expended by labour in production. It is interesting that this idea is an unconscious modern attempt to return to the primitive cost-of-production theory of value. In practice, of course, the value put by consumers on goods has no relation whatever to the number of ergs of energy, or hours of labour, expended in their production; so that an equation of monetary units to these cost units would have no practical significance whatever.

Why, in that case, it is sometimes asked, does it matter how many monetary units are issued at all? The answer is, for one reason only: because in the real economic world some costs are always fixed. If no costs were fixed, it would not matter theoretically how many money units were issued. If all costs were fixed, the system could not work anyway, however much money there was. But since *some* costs are fixed, the supply of money must in some way be adjusted to them.

The Twin Brethren, which make up the list of Seven, are the two Population Fallacies. These are delightfully simple and consist in the following two propositions: (1) all men are consumers but not producers; (2) all men are producers but not consumers. The second proposition is the more common. It is the foundation of the belief that unemployment implies over-population, and could accordingly be cured by emigration, birth control, or sterilisation. This Fallacy is a sort of perverted relic of Malthusianism. It forgets that men are consumers as well as producers, and that if the unemployed were spirited away, demand would fall and new unemployed would begin to take the place of the old. It fails to see that the problem is to get men's services exchanged, and not to abolish the men.

Less common is Proposition One: that all men are consumers but not producers. This proposition is assumed, however, in much familiar talk about capitalist and "imperialist" powers "searching for markets" abroad, as though it were possible to sell abroad indefinitely without taking something in return. The same idea is implied in "A. A. B.'s" remark about goods waiting fifty years for an increased population to consume them. Indeed, more fallacies than seven can be discovered in the two pregnant sentences quoted at the head of this article. If we except the pardonably inaccurate pleasantry that all engines are internal combustion engines, we may select two further delusions which, so far as we know, are "A. A. B.'s" own: (A) that population increases at a rate "corresponding" with the passage of years; (B) that goods dumped on the world to-day will be consumable fifty years hence. These two notions might be classified as Fallacy A and Fallacy B. But what are they, after all, among so many?

Iris Diaphragm for 74in. Telescope.

THE iris diaphragms used in photographic cameras as a means of varying the aperture of the lens are as familiar as the cameras themselves. The ingenuity of their construction must have been admired by all those who have examined them, but most engineers might be inclined to think that the principle was limited to the field of small instruments. It is a well-known fact that structural difficulties increase with the size of any mechanism, so that the design of the larger units cannot be based on a merely proportionate increase in the dimensions. Hence, perfect as might be the action of the iris diaphragm of an ordinary camera, the construction of an equally satisfactory apparatus of the same kind, but of vastly greater size, presents many problems which are absent in the case of its smaller prototype.

What is almost certainly the largest iris diaphragm ever made has recently been constructed in the optical works of Sir Howard Grubb, Parsons and Co., of Newcastle-on-Tyne. It forms part of the equipment of the 74in. reflecting telescope recently built by the same firm for the David Dunlap Memorial Observatory, of Toronto University. This diaphragm, a photograph of which, as it appeared in the makers' works before shipment, is reproduced in Fig. 1, serves to provide an infinitely variable aperture, from 12in. to 74in. diameter, for the great mirror of the telescope. It contains twenty leaves, each embracing rather more than half a circle, and pivoted at one end to the frame. These leaves are of sheet duralumin, 0·05in. thick. They are all moved in unison about their pivoted ends by means of a hand wheel and the mechanism about to be described, and thus the size of the central aperture is regulated at will.

The principle of the mechanism is illustrated in Fig. 3, while in Fig. 2 one leaf of the diaphragm is shown in three consecutive positions, namely, when the diaphragm is closed to 12in. aperture, when it is half opened, and when it is fully opened to 74in. aperture. It will be seen that each leaf 1 carries on its under surface a pivot 2 turning in a bush in the fixed frame 3. On the upper surface of the other end of the leaf a pivot 4 is mounted. A link 5 connects this latter pivot to another pivot 6 mounted on a rotatable ring 7 operated by a circular rack 8 and pinion 9. This link does not determine absolutely the motion of the end of the leaf, but simply serves to drag it along. It is evident that the proper path to be followed by the pivot 4 must be an arc of a circle with pivot 2 as centre. In small diaphragms the weight of the leaves in relation to their stiffness is negligible, so that, with the diaphragm lying in a horizontal plane there is no appreciable sagging of the leaves in the neighbourhood of the aperture, while if the diaphragm is vertical there is little tendency for the outer ends of the leaves to drop or move out of place as a result of the pivot 4 swinging about the centre 6, which would have the effect of displacing the aperture eccentrically. In these small diaphragms it is sufficient, in fact, merely to put a slot in the leaves for the pin 4 to traverse as the ring is rotated.

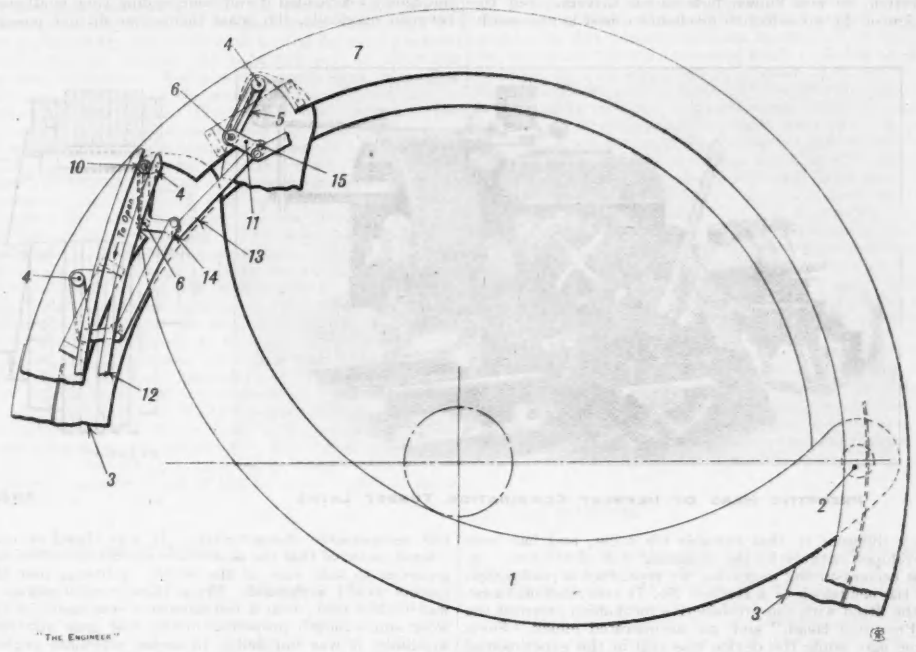


FIG. 3

In a large diaphragm, however, the weight of the leaves is much greater in proportion to their stiffness, and it therefore becomes necessary to give definite guidance to the outer ends of the leaves so as to prevent sagging and displacement. To provide this guidance the pin 4 is constrained to move in its proper circular arc by a roller 10 carried on the arm of a bell-crank lever 11, which is keyed to the same pivot 6 as that to which the link 5 is keyed. The roller has to travel along the track 12. Hence when the ring is rotated by the rack and pinion, the outer end of the leaf is correctly guided. There are twenty leaves in the diaphragm for the Toronto telescope, and if every leaf had been provided with its own separate roller and guides, the complication of the parts would have been very great. To avoid this complication, it was decided to link together the consecutive leaves in groups of five each, so that four sets of rollers and tracks would be sufficient for the guidance of the ends of all the twenty leaves in the diaphragm. To carry out this plan, the shorter arm of the bell crank lever 11 was arranged to carry links 13, coupling up the group of leaves it controls. It will be noticed that the pins 14 and 15 are not coincident. The reason for this is that the length of each link has to be equal to the distance between the fulcrum pivots of the bell crank levers, so that the mechanism defined by the centres of rotation 6, 6, 14, and 15 forms a parallelogram. The mechanism described is repeated for all the five leaves of the group. The result is that all the leaves are properly guided, so that undue sagging is prevented and the aperture of the diaphragm is kept central.

Reference to Figs. 4 to 6 will show that the hand wheel 16 carries a small pinion 17, which engages two gear wheels 18 and 19. The former wheel has 99 teeth and is securely fixed to the sleeve 20. The other wheel has 105 teeth, and is free to rotate upon the sleeve. It carries a graduated drum (21) which receives a very slow motion, owing to the differential nature of the gearing, and which serves to indicate the aperture of the diaphragm. The hand wheel is keyed to its spindle 22, on the other end of which is formed the pinion 9. The spindle is mounted in ball bearings. A circular top plate 7, with a diameter of 93½in., a thickness of ⅛in., and with a central hole 80½in. diameter, carries a rack 8 secured near its outer edge, and this rack engages with the pinion on the hand wheel spindle. The plate is supported and centred by eight brackets—see Fig. 4—provided with top, bottom, and side rollers, so that it can be rotated as desired to open or close the diaphragm. The leaves are pivoted at 2 on the main supporting ring shown in Fig. 5, the above-mentioned brackets being also bolted to this ring. The other ends of the leaves are connected to the rotatable top plate 7 by means of the links 5. The bell-crank levers carrying the guide rollers are shown in section in Fig. 6. The track 12 in which the guide rollers run is held by brackets 12A, carried by the main supporting ring. The hand wheel rotates the top plate through an arc of a little less than 90 deg., and in so doing varies the aperture from 12in. to 74in. diameter. Any desired aperture can be obtained by reference to the graduated drum. To reduce the scattering of light from the surfaces of the leaves, the latter were given dark matt surfaces by anodic treatment carried out by the Royal Aircraft Establishment at Farnborough, to the requirements of Sir Howard Grubb, Parsons and Co.

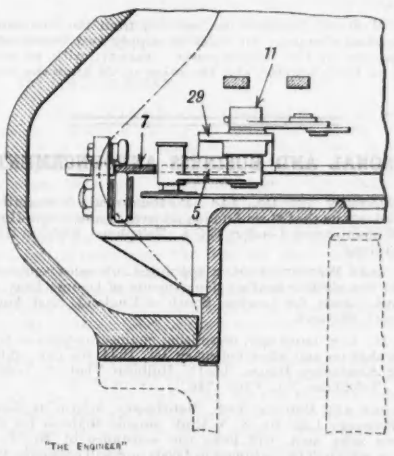


FIG. 4

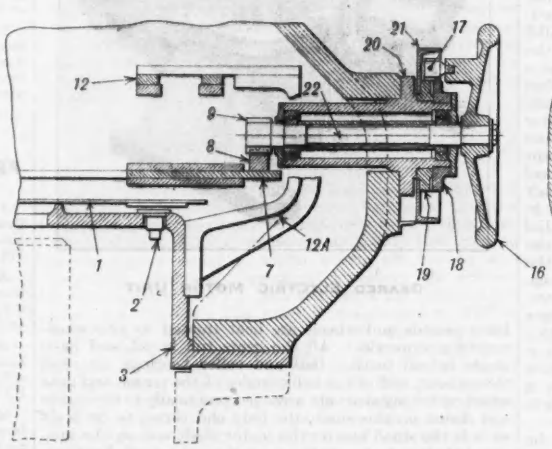


FIG. 5

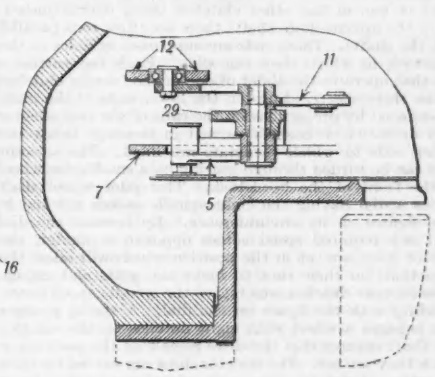


FIG. 6

A TEST made of 196 different kinds of paints and other coating materials for the protection of the inside surfaces of steel tanks for the storage of water, made by the Pittsburgh Des Moines Steel Company, showed that certain types of paints of the synthetic gum vehicle type are best suited for such work, and that one particular paint with a bakelite resin base vehicle was rated at 100 per cent. of its original condition at the conclusion of the test. A point of interest is that the water contained appreciable amounts of magnesium chloride and the same result would not necessarily be true for a less corrosive water.

A "Pre-selective" Headstock.

EVERY reduction in actual cutting time increases the relative importance of reducing idle or non-cutting time on a machine tool, and the advent of new cutting alloys in recent years has made this point of even greater importance than heretofore. The possibilities in the direction of the reduction of idle time by the improvement of the single pulley all-geared headstock were almost exhausted some time ago. Air-operated chucks and electrical controls did much to reduce idle time still further, but the improvements thus made were comparatively small. The coming of a new design of headstock which will effect a very considerable saving of time cannot, therefore, be regarded as completely unexpected.

The new head now brought out by Alfred Herbert, Ltd., of Coventry, makes use of the principle of pre-selection, so well known now to car drivers. But the design of the pre-selective mechanism used is necessarily very different to that suitable for a car, and has been developed entirely by the designing staff of the firm. In the accompanying engraving we reproduce a photograph of the headstock of a Herbert No. 7A combination turret lathe fitted with the pre-selective mechanism, termed the "Preoptive Head," and an air-operated chuck. Some time ago, while the device was still in the experimental stage, we were privileged to see one of these lathes in action, and were at once impressed by the speed at which it could be operated. Even if the turner comes to the new lathe fresh from the older type, he can effect a saving of time in gear changing, but with one accustomed to the controls and using them with intelligent foresight, it seemed almost possible for the machine never to stop cutting at all until the job was finished!

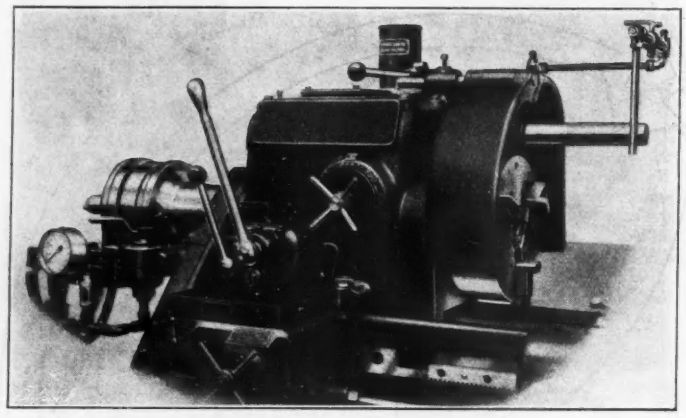
The headstock contains a driving shaft, three intermediate shafts, and the main spindle. On the driving shaft is mounted a multiple disc clutch operated by a hand lever on the top of the headstock for starting and stopping the lathe. This clutch has a patented adjustment which is positive and easily accomplished. When the clutch is released a brake is applied to stop the spindle. Each of the first two intermediate shafts has a double multiple disc clutch of the same type as that on the driving shaft. The clutch members on these shafts carry driving and driven gears near the ends of the shafts close to the bearings. The third intermediate shaft has a double multiple disc clutch, which is self-adjusting and spring-loaded to a definite slipping point, so that it safeguards the gears in the headstock from overload and shock in the event of one of the other clutches being over-adjusted. Below the intermediate shafts there are three rods parallel with the shafts. These rods are supported in holes in the headstock in which they can slide. Each rod carries a glut that operates the slider of one of the friction clutches on the three shafts. Lugs on the lower ends of the gluts are engaged by projections on the rims of the two selector discs mounted on a shaft carried in bearings below the sliding rods to which the gluts are fixed. The selector discs can be turned through gearing by a small pilot wheel on the front of the headstock. This pilot wheel shaft carries a dial having the eight spindle speeds marked in large figures on its circumference. By turning the dial until any required speed comes opposite a pointer, the selector discs are set in the position which will allow the projections on their rims to move the gluts and engage those friction clutches which give the spindle speed corresponding with the figure on the dial. A spring plunger that engages a wheel with eight notches on the selector disc shaft ensures that the discs remain in the position in which they are set. The selector discs are moved on their respective shafts to engage the friction clutches by a powerful lever at the front of the headstock, which acts through a cam and pair of bell cranks.

When the clutch lever is released, a spring returns the selector discs to the original position. If the clutch lever is not moved, the selector discs may be turned freely into any position by the pilot wheel without producing any effect on the spindle speed.

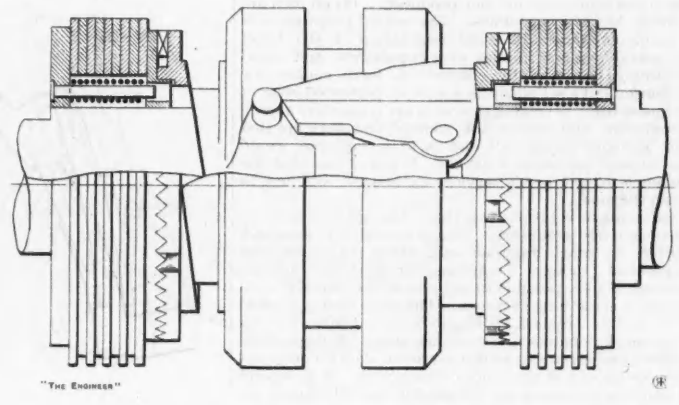
Thus the dial can be set for the next spindle speed required while the previous operation is still in progress. Subsequently, a pull on the clutch lever instantly brings the new spindle speed into use. Reverse to the spindle is obtained by operating the small lever on the left of the main speed-changing lever. When this small lever is moved to the right, two of the speeds, marked on the dial with a star, become reverse speeds.

In the other engraving there is reproduced a drawing of the Herbert patent multiple disc clutch. Adjustment of this clutch is provided by the serrated discs. The face of each of these discs is a cam, which engages with the end face of the clutch lever. By inserting a tommy bar into notches on the discs, they can be moved one or two serrations to provide the necessary amount of friction when the clutch is engaged.

In other respects the new headstock is very similar in design to those which have been fitted to the corresponding lathe in the past, and there is no need for us to refer further to these details.



PREOPTIVE HEAD OF HERBERT COMBINATION TURRET LATHE

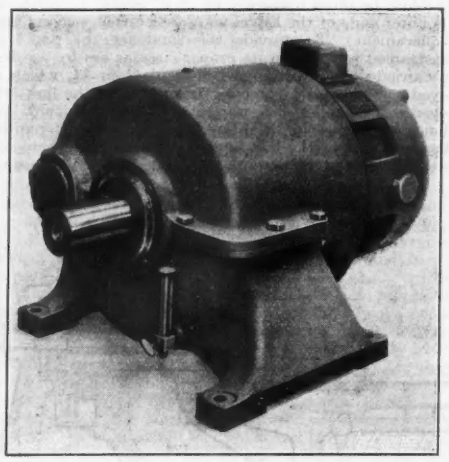


ADJUSTABLE MULTIPLE DISC CLUTCH

Geared Electric Motor Units.

FOR industrial applications where a low-speed drive is required, the British Thomson-Houston and Metropolitan-Vickers companies have produced a range of geared motor units in the form of a compact and reliable combination of electric motor and speed-reducing gear. The units are designed so that the motor is carried on the gear-box. In designing these units the fact was kept in mind that, whereas an electric motor can be severely and frequently overloaded if sufficient cooling time is allowed between overloads, the gears themselves do not possess this recuperative characteristic. It was therefore considered essential that the dimensions should be sufficiently generous to take care of the worst conditions that the motors would withstand. From these considerations it was evident that, even if full allowance was made for the wear and strength properties of the best gear materials available, it was impossible to secure adequate gearing sufficiently small in size to enable the speed-reducing mechanism to be carried on the motor frame. Therefore, in this design, as already stated, the motor is carried on the gear-box, and not the gear-box on the motor. In addition to permitting the use of gears of generous dimensions, this design allows the use of a low-speed shaft sufficiently stout to carry a pulley, chain, or gear wheel without the use of a third bearing.

The gear-box pinions are of nickel-chrome steel, and the gear wheels are made from solid forged steel slabs.



GEARED ELECTRIC MOTOR UNIT

Both pinions and wheels are heat treated to give wear-resisting properties. All the gears run in oil, and have single helical teeth. Ball and roller bearings are used throughout, and as the helix angles of the pinion and gear wheel on the lay shaft are arranged practically to neutralise end thrust on this shaft, the only end thrust to be dealt with is the small one on the motor shaft and on the low-speed shaft, which is taken care of by the shaft bearings. As the motor shaft and the low-speed shaft are in line, the overall height of the unit is kept small.

These geared units incorporate D.C. or A.C. motors the latter being of the squirrel-cage or slip-ring type, according to the conditions of service.

THE BRITISH EXECUTIVE EMPLOYMENT SOCIETY.

As a direct result of hearing the broadcast speech made by H.R.H. the Prince of Wales last January, Mr. Ronald Ogden, M.A., F.R. Econ. S., feeling that a large amount of talent and energy was being wasted through the compulsory idleness of able and well-qualified men, put an advertisement in one of the daily papers, asking men in a position similar to his own to get into touch with him, with a view to working out a scheme of self-help. About 500 men answered his advertisement, and the British Executive Employment Society began its work. The nucleus of a voluntary staff from among the unemployed Executives was formed, and the staff is still composed of actual members of the unemployed executives' class, who are glad to work for the good of their fellows. The employment bureau was set up and licensed, although it should here be mentioned there is no charge for finding positions for members, beyond the initial 5s. subscription to the club. Sir Noel Curtis-Bennett consented to become President of the Society, and has taken a most active part in helping the founder, Mr. Ogden, through the many difficulties encountered during the first year; while Sir William Crawford, Sir W. H. Peat, and Lord Melchett became Vice-presidents. Other influential men, such as Lieut.-Colonel George Crosfield, Lieut.-Colonel E. ff. W. Lascelles, are members of the Executive Council. A very thorough system of classification is employed, and from it the detailed records, the training, experience, and qualifications of every member are available at a moment's notice, cross-indexed under various categories and sub-headings, civil, mechanical, electrical, metallurgical, and so forth, in readiness for any vacancy which may occur. The policy of the Society is to build up by continual enrolment of new members on the one side and co-operation with employers on the other side, an employment exchange for the higher-grade executive and technical posts.

The Society's interpretation of the word "executive" implies that he is a man who is capable of taking charge of a department, accustomed to control staff, technical or commercial, and of carrying out the policy of an administration or directorate. Such men with the requisite qualifications are the products of education, training, and experience. The Society offers facilities for putting the right men who are available owing to the misfortunes that have come upon them, into personal touch with the business chiefs who have the right jobs.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

VICKERS-ARMSTRONGS, Ltd., have received from the Ribble Navigation an order for two hydraulic cranes for the Preston Dock. The cranes will be made at Elswick Works, Newcastle-on-Tyne.

THE MARCONI COMPANY has received from the Roumanian Broadcasting Company an order to supply two broadcasting stations, one of the "super-power" variety, with an aerial energy of 150 kilowatts, and the other of 20 kilowatts aerial power.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

J. DAMPNEY AND CO., Ltd., Portland-road, Newcastle-on-Tyne, advise us that their London address is now Regis House, King William-street, London, E.C.4. Telephone, Mansion House 7781 (3 lines).

MR. ALAN WRIGHT has been appointed sole sales representative for the electric heating departments of George Bray and Co., Ltd., Leeds, for London, South of England, East Anglia, and South Midlands.

MR. H. A. S. GOTHARD, consulting engineer, wishes it to be known that on and after February 1st, 1934, his new address will be Kimberley House, 14–17, Holborn Viaduct, London, E.C.1. Telephone No.: City 1746.

HOLDEN AND BROOKE, Ltd., Manchester, inform us that as from February 12th Mr. S. N. Clift, outside engineer for their northern sales area, will have the assistance of Mr. E. H. Prentice, who will be stationed in Leeds and will cover the West Riding district.

FREDK. BRABY AND CO., Ltd., Deptford, have acquired a controlling interest in the G.C. Engineering Company, Ltd., manufacturers and designers of conveyors and complete canning lines. Mr. R. F. Graham and Mr. S. C. Calladine are being retained on the board.

COPES REGULATORS, Ltd., Burleigh House, 5/11, Theobalds-road, London, W.C.1, announce that they have been appointed the sole distributors in Great Britain and the Dominions for thermo-electric pyrometers, recorders, and heat control apparatus, as manufactured by Ether Ltd., Birmingham.

2500 KW MOTOR CONVERTERS.—Owing to a slip the total number of poles on the 2500 kW motor converters described in our issue of January 26th was given as eight instead of twelve. The D.C. portion of each machine has eight poles, and the A.C. portion four poles, giving at 50 cycles per second a synchronous speed of 500 r.p.m.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Higher Prices for British Steel.

An important change in the relations of the British steel makers and the re-rollers has taken place this week, and one which will have far-reaching consequences for the British steel market. In our issue of January 19th (page 61), we referred to the negotiations which had been carried on between a committee of re-rollers and billet makers, and which had resulted in definite proposals being placed before the former industry. These included the extension of price control to certain sizes of steel bars and strip, which were produced by both steel makers and re-rollers, and which previously had been allowed a free market. It was also suggested that the re-rollers should agree to operate this scheme for a trial period of six months, and that prices should be advanced in accordance with a prepared schedule. The scheme has been adopted, and from to-day the price for small bars—that is, rounds under 3in., and flats under 5in.—has been advanced from £7 10s. to £8 14s. 6d. d/d London. This may be taken as the first step in reorganising the market, as it brings within the steel makers' control scheme those sizes which individual works have been able to quote at their own prices. It was generally recognised that this freedom gave a certain elasticity to the old price control, as most contracts included "free" sizes, and by quoting a cheap price for these a lower overall quotation was possible. It was, of course, a form of price-cutting and many steel makers objected to it. It is understood that all the steel makers and nearly all the re-rollers are in the new scheme, and it now remains to be seen if the Continental producers will leave their price for bars at the present figure of £6 19s. 3d. d/d Birmingham and including duty.

Steel Reorganisation.

It would appear that the National Steel Committee's Scheme for the reorganisation of the industry, which is to be considered by the members of the National Federation of Iron and Steel Manufacturers at a meeting on February 22nd, will not be received with unanimous approval. Wide differences of opinion were expressed at the annual dinner of the London Iron and Steel Exchange on January 30th by two such prominent leaders of the industry as Mr. Charles Mitchell, chairman of Dorman, Long and Co., Ltd., and of the National Committee, and Sir William Firth, chairman of Rd. Thomas and Co., Ltd. Sir William attacked the scheme as one which would make co-operation "palatable to all by making it as comfortable and as profitable as possible." It was not a National Scheme, because it would do nothing to reduce the costs of production. and "the only factor it would eliminate would be price competition in the home trade." He called for temporary Government control through which owners of badly situated and redundant works would be forced to dispose of them for a reasonable compensation. Mr. Charles Mitchell, who spoke later, profoundly disagreed with Sir William, and said that the trade did not want temporary Government control and would not have it. He hoped the Government would say that the industry had shown a ready spirit and that in return it was prepared to continue the protective duties, not until next October, but for x years. That would be all the industry wanted. It is understood that these two speeches have had considerable repercussions in the steel industry, although probably they have done no more than consolidate opinions already formed. It has long been known that certain sections of the trade distrusted the policy followed by the reorganisation scheme, although it is doubtful if the opposition will go so far as to reject the Committee's proposals entirely.

The Pig Iron Market.

There is no sign of the demand in this department relaxing. Business during the first month of the year was on quite as good a scale as during December, in spite of the rather quiet conditions which ruled just after the Christmas holidays. The production of Cleveland iron is still insufficient to meet the requirements of the market, and it is difficult to place orders for prompt delivery. Consumers on the North-East Coast are prepared to contract for delivery over the first six months of the year; but in only a few cases have the producers been willing to accept business for so far ahead, and in those instances premiums over the official prices have been required. The Scottish light castings makers are also anxious to cover their forward needs, although the pressure from this quarter is not so great as from the local users. The decision of the producers at the end of the month not to raise their prices was received with relief by the market, but if the practice of charging premiums grows it will be the same as though an advance had actually been made. Only four furnaces are producing Cleveland, and it seems doubtful if the stringency in the market will be eased for some time. Some export business has been transacted, because producers desire to retain their overseas connections and for this reason are prepared to accept competitive prices. The quantities involved, however, have not been large. The Midland pig iron producers also have kept their prices unaltered. Forward buying seems to be largely confined to Derbyshire brands, as the Northamptonshire makers are disinclined to enter into commitments at current prices. A certain amount of business, however, has been done in small parcels for near delivery. As a result of this situation the stocks of Derbyshire iron are likely to be reduced, but at present they are of somewhat unwieldy proportions. The position in the hematite market is satisfactory and the home demand is well maintained, particularly from Sheffield and the Midlands. Producers are reluctant to sell forward, as they are uncertain regarding their future costs. There is also a strong demand for basic iron and another furnace has been started at the Redcar works of Dorman, Long and Co., Ltd.

The Midlands and South Wales.

Although the amount of business now being transacted is probably less than a few weeks ago, there has been no diminution in the operations at the works. There is a light demand for joists and angles, which reflects the quiet conditions which are being experienced by the constructional engineers. Most of the manufacturers are anxious to obtain fresh orders, but at the moment there seems little business about. The prospect of increased prices resulting from the reorganisation scheme has led to a certain amount of forward buying by the structural engineers, but this has not been sufficient to affect the general situation. Business in small bars, also, has declined, although all the works have heavy tonnages of orders on their books. The position has changed to the extent that whereas a short time ago it was difficult to obtain anything like near delivery, most of the works are now able to meet customers in this respect. It is reported that the tonnage of steel ordered on the Continent has increased of late, and this to some extent would account for the slackening in the demand for the British re-rolled material. The price of Continental merchant bars was raised over the week-end by the movements of the exchange to £4 9s. 6d. f.o.b., which would work out at £6 19s. 3d. d/d, including duty. Apparently it has been possible recently to buy at below the official quotation, in spite of the regulations of the Continental Steel Cartel, but naturally it is difficult to verify such transactions. The demand for colliery steel is steady rather than active, but there has been a call recently for arches and roofing bars. No improvement is noticable in the position in the South Wales tin-plate market, and as a consequence some of the steel works making tin-plate bars are not so well employed. The Welsh engineering concerns, however, are moderately busy and the ship repairing yards in South Wales have more work in hand than for a long time.

Scotland and the North.

The volume of new business in manufactured steel has declined somewhat in the Scottish market. Specifications, however, are being received in a steady stream and the works have prospects of several months' employment before them. The structural engineers in Scotland do not seem busy and are placing only a moderate amount of business for steel materials. The plate mills are well employed and are working upon some fairly large export orders which they obtained recently. The re-rolling branch of the industry is well employed and there is still a strong demand for small bars and sections from home users; but export business is slow. Conditions in the sheet trade do not alter much and business is principally confined to home trade requirements, the demand being for the heavier gauges. In Lancashire the market for finished steel does not develop according to expectations and this is attributed by many to hesitation on the part of producers and users as a result of uncertainty regarding the possible effects of the reorganisation scheme. Business is most active in small steel bars, hoops and strip, the demand from the heavy branches of the industry being rather disappointing. Perhaps one reason why consumers have entered into contracts for the lighter materials is that hitherto most of these descriptions have enjoyed a free market; but now prices have been fixed and brought under control. It is only natural, therefore, that buyers secured their position as much as possible before the scheme came into force. Only a moderate business has passed lately in boiler plates, for which the general quotation is £8 5s. In the Barrow and Workington districts conditions are satisfactory and the works have recently added a considerable number of miscellaneous orders to those already on their books.

Manufactured Iron.

The market for finished iron has not improved since the end of 1933 to the same extent as that for steel; but there has been a definite expansion in business. Some of the Midland marked bar plants are running practically at capacity, whilst others are not so well employed. Generally speaking, however, the outlook in this department is not bad, as most of the makers have good order books. The price is maintained at £12 at works. The demand for the cheaper qualities of bar iron is much less satisfactory, and the works have a certain amount of unemployed plant. The prices of Crown quality range from £8 10s. to £9 10s. The market generally seems surprised that the practical elimination of competition of cheap Belgian iron has not led to a much greater use of British material. Naturally, the demand for the home product has increased since the protective duties were imposed, but not nearly to the extent that was expected. Common bars, of domestic manufacture, are quoted at £6 17s. 6d. to £7 10s. d/d, the price of Belgian bars being about £7. In Scotland the mills are not fully employed, but the recent orders given out by the railway companies have led to some useful contracts for bar iron required for this work. The demand from the agricultural machinery makers and for horseshoe quality iron has been disappointing for months, and there seems no likelihood of an early improvement. Scottish Crown bars are quoted at £9 15s. d/d Glasgow, and £9 5s. f.o.b. for export.

Copper and Tin.

The electrolytic copper market has a distinctly better appearance than for some time, and prices, after developing a slightly easier tone early in the week, recovered later. To some extent the firmer markets in America were responsible for this, and in the middle of the week the United States producers were reluctant sellers. The American price was held at 8.20 c. to 8.25 c. c.i.f., or £37 5s. to £37 10s. At this price there was a fair amount of buying by the Continent and a few English consumers also entered the market. The American domestic price has been steady at 8 c. d/d, but it is no secret that the producers are not satisfied with this figure, and there has been a tendency amongst them to hold off the market. Consumers appear to be slowly covering their requirements, but are still bare of stocks, and the position in this respect continues to cause some anxiety. Any sustained upward movement would probably occasion a rush of buying, and cause an inflation in values, which the market does not want, as it is realised that a steady improvement will be more permanent than the violent fluctuations which invariably result from panic buying. On the London standard copper market prices have been steady. There has been a fair amount of speculation, and some bull realisations, which, however, have had little influence upon values. There is no doubt, however, that this market is much swayed by the movements of the exchanges. . . . The tin market has had an uninteresting appearance for some time, and the price fluctuations have been narrow. The statistics published at the end of the month were fairly satisfactory, although perhaps not so good as the market had expected. The visible supply had decreased by 1362 tons to 20,121 tons, whilst the carry-over in the Straits Settlements and at the Arnheim Smelter showed an increase together of 596 tons. The deliveries were again rather disappointing, totalling 6150 tons, the American share being only 3310 tons. Sentiment in the market is confident, and the belief prevails that the American delivery figures do not indicate the true position and that consumers there have been working on stocks which they will soon have to replenish.

Lead and Spelter.

Practically the only feature in the lead market has been the steady demand from consumers. It is not so large as in the early autumn, but considering the time of year it is regarded as being on a satisfactory scale. It is suggested that if consumers can take the quantities now going into their works in the early part of the year, the demand should be unusually heavy later on, when the normal buying season starts. There are not likely to be important arrivals this month, but there is more than sufficient lead in warehouse in this country to meet any requirements which may develop. . . . Business in spelter continues to run on disappointing lines. There is no doubt that, comparatively speaking, the price of this metal is cheap, and this is an argument which always has an influence upon the market. Lately, there has been a demand for Empire brands which has resulted in premiums of 5s. to 10s. being paid, although probably there is no shortage of this kind of spelter. Shipments of Mexican spelter will shortly reach this country, and at times when the price is sufficiently attractive Continental makers send spelter to the London market. This metal is sold subject to duty and as buyers naturally avoid taking it whenever possible, it has a tendency to depress prices. Probably the Empire producers, knowing this, refuse to allow the quotation for their metal, which is free of duty, to decline to the same figure as the foreign spelter, and this would explain the demand for premiums.

Average Metal Quotations.

The non-ferrous metal markets fail to show the resiliency which might be expected in view of the advance in most commodity prices. The London Metal Exchange official average quotations for January show that only in the copper market was there an increase in price. Previously the average price of the metal had declined for four consecutive months in common with those of lead and spelter. In January, however, the official average for cash copper advanced by £1 5s. 1d., for three months by £1 5s. 3d., and for electrolytic by £1 4s. 4d., whilst for wire bars and best selected the quotations were £1 2s. 11d. and £1 7s. 9d. respectively higher than in December. The decline in the average price of tin as compared with the average for December was only £1 0s. 7d. for cash and 19s. 11d. for three months, an insignificant movement in a market which is noted for wide fluctuations. In lead also the steadiness in prices is shown by the fact that for metal for shipment "the current month" the price was 2s. 7d. below the December figure, and for shipment the third following month 2s. 9d. less, whilst the mean price was 2s. 8d. lower. The average spelter quotation was 2s. 9d. cheaper for shipment the "current month," 2s. 4d. for shipment the "third following month," whilst the mean quotation was 2s. 7d. down compared with the December average. The following are the official average quotations for January :—

Standard Copper	Cash	£32	12	0 5/8
	3 Months	£32	14	8 11/16
	Settlement	£32	12	11 9/16
Electrolytic Copper		£35	18	6 7/16
Electrolytic Wire Bars		£36	4	9 7/16
Best Selected Copper		£35	9	8 1/2
Standard Tin	Cash	£226	14	3 7/16
	3 Months	£226	15	8 7/16
	Settlement	£226	14	1 7/16
Lead	For shipment the current month	£11	6	0 31/32
	For shipment the third following month	£11	10	4 1/16
	Mean	£11	8	2 15/32
	Settlement	£11	6	8 7/16
Spelter	For shipment the current month	£14	13	9
	For shipment the third following month	£14	18	10 1/4
	Mean	£14	16	3 13/32
	Settlement	£14	14	1 7/16

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Hematite Mixed Nos.	3 2 6	3 0 0
No. 1	3 3 0	3 0 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 5 0	3 1 0
No. 3 G.M.B.	3 2 6	2 18 6
No. 4 Forge	3 1 0	2 17 0
Basic	3 5 0	—
MIDLANDS—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 6 0	—
„ „ Forge	3 1 6	—
Basic	3 10 0	—
Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 6 0	—
No. 1 Foundry, ditto	3 7 6	—
No. 3 Foundry, ditto	3 5 0	—
Basic, d/d	3 6 0	—
N.W. COAST—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow; 4 0 6 „ Sheffield; 4 5 6 „ Birmingham	

(*Basic iron prices subject to a rebate of 5/–.*)

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
LANCS.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
MIDLANDS—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. COAST—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
LONDON AND THE SOUTH—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	—
Plates, ¼in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 7 6	8 5 0
NORTH-EAST COAST—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 0 0
Plates, ¼in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 2 6	8 5 0
Boiler Plates, ¼in.	8 5 0	7 12 6
MIDLANDS, AND LEEDS AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 0 0
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 2 6	8 5 0
Boiler Plates, ¼in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
GLASGOW AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 0 0
Plates, ¼in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
SOUTH WALES AREA—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 0 0
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 7 6	8 5 0

IRELAND—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	8 15 0	8 15 0
14-G. to 20-G., d/d	10 0 0	9 0 0
21-G. to 24-G., d/d	10 5 0	9 5 0
25-G. to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/3 to 16/6.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic, Soft (25·41% C.)	6 0 0
„ Medium (0·42% to 0·60% C.)	6 17 6
„ Hard (0·61% to 0·85% C.)	7 7 6
„ „ (0·86% to 0·99% C.)	8 7 6
„ „ (1% C. and up)	8 17 6
Soft (up to 25% C.), 500 tons and up	5 5 0
100 tons	5 12 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/9 per lb.	
Ferro Tungsten	2/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 12 6	7/–
„ „ 8 p.c. to 10 p.c.	£21 12 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£36 10 0	11/–
„ „ „ 1 p.c. carbon	£37 10 0	11/–
„ „ „ 0·70 p.c. carbon	£38 15 0	12/6
„ „ „ carbon free	10½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 7 6 scale 5/– p.u.	
„ „ 75 p.c.	£17 0 0 to 17 10 0 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/3 per lb.	

NON-FERROUS METAL.

Official Prices, February 7th.

COPPER—		
Cash	£33 12 6 to £33 13 9	
Three months	£33 16 3 to £33 17 6	
Electrolytic	£36 10 0 to £37 0 0	
Best Selected Ingots, d/d Birmingham	£37 5 0	
Sheets, Hot Rolled	£64 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10d.	10d.
„ Brazed (basis)	10d.	10d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
„ Brazed	11d.	11d.
TIN—		
Cash	£226 15 0 to £227 0 0	
Three months	£226 0 0 to £226 5 0	
LEAD	£11 13 9 to £11 18 9	
SPELTER	£14 17 6 to £15 5 0	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

		Export.
LANARKSHIRE—		
(f.o.b. Grangemouth)—Navigation	Unscreened	13/3 to 13/6
„ Glasgow—	Ell	13/6 to 15/3
„ „	Splint	16/6
AYRSHIRE—		
(f.o.b. Ports)—Steam		12/3 to 12/6
FIFESHIRE—		
(f.o.b. Methil or Burntisland)—Steam		13/6 to 13/9
Unscreened Navigation		12/3 to 13/3
LOTHIANS—		
(f.o.b. Leith)—Hartley Prime		13/9 to 14/–
Secondary Steam		13/– to 13/6

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	17/6 to 20/6
Furnace Coke	13/– to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	14/– to 14/6
„ Second	13/– to 13/3
„ Best Small	10/6 to 11/–
Unscreened	12/– to 13/6
DURHAM—	
Best Gas	14/8
Foundry Coke	17/– to 19/6

SHEFFIELD—	Inland.
Best Hand-picked Branch	27/– to 28/–
South Yorkshire Best	22/– to 24/–
South Yorkshire Seconds	17/6 to 19/6
Rough Slacks	6/– to 9/–
Nutty Slacks	7/– to 8/6
Furnace Coke (at ovens)	12/3

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/–
Foundry Coke	21/– to 36/–
Furnace Coke	18/6 to 20/–
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm	9/6 to 10/6
Steam Coals:	
Large	18/– to 20/–
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ½d. per gallon extra

French Engineering Notes.

(From our own Correspondent in Paris.)

The Industrial Future.

THE aim of the French commercial administration in negotiating arrangements with other countries during the past few years has been to secure for France complete fiscal independence so that she will not be hampered by any such considerations as the "most-favoured-nation" clause in her dealings abroad. That independence is not yet complete, although obstacles to the framing of a new commercial policy have been sufficiently removed to enable the French Government to inaugurate a method of negotiation which aims at obtaining the maximum of advantage from each country in return for concessions that would not be possible without this freedom from obligations towards other countries. The practice of dividing up quotas and reserving percentages of quotas for the purpose of negotiation has had the unexpected result, for the French, of raising the question of discrimination which threatens to wreck the whole system. It is difficult to see how the quotas, as applied by the French, can avoid discrimination. The difficulties arising out of the system are fully realised in this country, where they have produced complications that threaten to close still further the foreign markets for French goods. The origin of this policy was the industrial nationalism which grew up after the war, when it was believed that freedom from dependence upon other countries for supplies and the creation of an adequate system of production were necessary factors in national defence. With vast colonial possessions it was supposed that the country could live on its own resources. There is an influential section of economists, as well as the whole of the exporting industries, which deplore the carrying out of a policy that, in the end, can do little for the country's general prosperity, although they admit that in present circumstances it is difficult to modify that policy considerably without endangering the existence of certain manufacturing industries. It is now clear that the possibilities of producing in the colonies all that has been imported from abroad have been greatly overrated. The State has burdened itself with a huge expenditure for the encouragement of colonial industries, the products of which are often of inferior quality and cost much more than what is imported, while the restriction of imports has had the inevitable result of lessening the demand for French goods from countries which formerly supplied produce that is now grown at considerable cost in the colonies. There is consequently a demand that the Empire Conference should be held as early as possible in order to co-ordinate production in the colonies, which would produce only what can be supplied in competition, while everything else of better quality and at a lower cost would be imported. The home exporting industries would therefore find a wider market for their goods, and there would be a return to normal trading when it is probable that highly protected manufacturing industries would suffer. Nevertheless, the general result would be favourable to national prosperity. Attempts are now being made to popularise the idea that each country should profit from the superior and cheaper products of other countries, but these attempts can have no practical effect so long as it is feared that what is left of the national industrial activity is threatened by the general economic dislocation.

Shipping.

The creation of a commission to consider the ways and means of enabling the merchant marine to collaborate effectively in a scheme for protecting national production was decided upon by the Association of Industry and Agriculture after hearing a statement by Monsieur Cangardel, managing director of the Compagnie Transatlantique, upon the present precarious condition of shipping. Monsieur Cangardel explained how necessary it was for the mercantile marine to receive the fullest support from those engaged in home and foreign trade. His account of the state of the shipping industry revealed the critical situation of shipowners, who are unable, without assistance, to compete for freights with countries that have gone off the gold standard. If all the goods handled by French traders were carried in French ships it would, he said, be possible for owners to help national production and at the same time they would be better able to compete for international traffic.

The "Atlantique."

The English underwriters have lodged an appeal against the decision of the Tribunal de Commerce de la Seine in favour of the claim of the Compagnie Sud Atlantique for the payment in full of 170 million francs, together with interest from March last and all costs, for the loss of the "Atlantique," which was burnt out in the English Channel. No action has yet been taken by the French insurance companies. The legal representative of the Compagnie Sud Atlantique states that the company will endeavour to obtain immediate payment of the amount secured to it by the decision of the Court, and will provide a guarantee to refund the amount received in the event of the appeal being allowed.

Paris Water Supply.

While arrangements are in progress to carry out works to bring a million cubic metres of water to Paris daily from the Vals de Loire, the execution of the undertaking will probably occupy so long a time that the Paris municipality has voted an expenditure of 10 million francs for improving the supplies from existing sources. There is also some objection that the hundred miles of aqueduct from Briare to Paris would prove vulnerable in the event of hostilities, and that consequently the existing supplies should be preserved. At present the daily consumption in Paris is 852,000 cubic metres, while the suburbs take 600,000 cubic metres. Water is drawn from the Seine at the rate of 26 cubic metres a second, and this causes trouble in times of drought, for which reason it has been found necessary to construct reservoirs to supplement those now existing with a capacity of 600,000 cubic metres. At Saint-Cloud the capacity of the reservoir will be increased by 150,000 cubic metres. Work will also be carried out for the preservation of aqueducts, notably the Vienne, which shows signs of sagging and will have to be consolidated, if not partly rebuilt.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

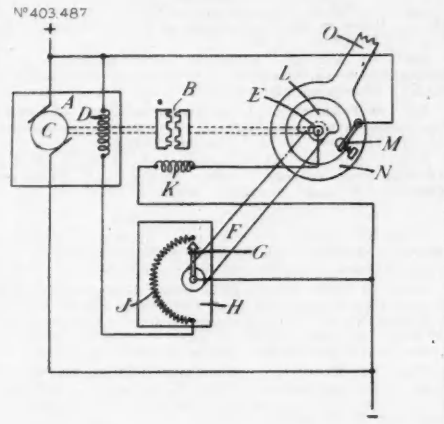
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

403,487. September 22nd, 1932.—STARTING RHEOSTATS FOR ELECTRIC MOTORS, The English Electric Company, Ltd., of 28, Kingsway, London, W.C.2; Charles Tate Scarf, of "Woodcroft," Rednal, Worcestershire, and Edward John Bertles, of 1, Norbury-road, Eccleshill, Bradford.

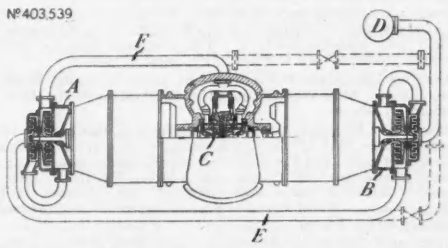
This specification describes a motor-starting rheostat driven by an auxiliary motor under the control of a manual device, and has for its object to ensure that the main motor is accelerated at a desired predetermined rate up to the speed determined by the manual regulator. A liquid rheostat is driven by a continuously running electric pilot motor A, through a clutch B. The motor has an armature C connected between positive and negative mains and a shunt field winding D. The moving electrode of the liquid rheostat is operated by the shaft E. Driven from this shaft by a sprocket and chain, or other driving means F, is the moving arm G of the regulator H, the resistance J of which is connected in series with the shunt field D. As the shaft E moves to decrease the resistance of the liquid rheostat, the arm G is moved to cut resistance out of the shunt



field circuit and reduce the speed of the pilot motor A, which will thus depend solely on the position of the moving electrode. The clutch B is normally out of engagement, and is adapted to be pulled into engagement when the magnet coil K is energised. Mounted on the shaft E and rotating with it is the contact sector L. The resilient contact finger M, which is adapted to engage and rub over the sector L, is mounted on a member N, which is concentric with the shaft E and may be rotated by means of a handle O. Movement of the handle in a counter-clockwise direction brings the contact finger M on to the sector L, closes the circuit of the clutch magnet coil K, and so brings the clutch into engagement and starts the rheostat in motion. When the shaft E has reached a position corresponding to the position of the hand lever O, the rotating contact segment L separates from the contact finger M, and the clutch magnet is de-energised, thus bringing the rheostat to rest. The clutch B is preferably operated directly by a lever attached to the armature of the electro-magnet having the coil K, but, if desired, the coil K may control an alternative form of mechanical or fluid pressure device for operating the clutch.—*December 28th*, 1933.

403,539. February 27th, 1933.—RADIAL FLOW TURBINES, *H. G. C. Fairweather, 65, Chancery-lane, London, W.C.2.*

This turbine is, in general, of the familiar Ljungstrom type, with oppositely rotating blade discs and generators, but it has, in addition, two high-pressure radial-flow turbines, A and B, on the extremities of the shafts. Each of these turbines has two discs, and their areas are so proportioned that the end

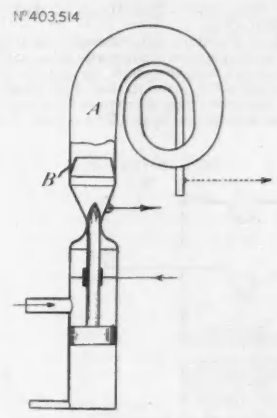


thrust on the shaft balances that of the main turbine C. High-pressure steam from D is first expanded in the turbine B; it is then conducted by the pipe E to the turbine A, and, finally, by the pipe F to the main turbine. Alternative connections from the main steam pipe, shown by broken lines, are provided to carry overloads. It is said that end thrusts on the shafts are virtually balanced in all conditions of running.—*December 28th*, 1933.

SWITCHGEAR.

403,514. November 5th, 1932.—ELECTRIC SWITCHES WITH ARC-EXTINCTION BY VAPOUR-BLAST, *International General Electric Company, Incorporated, of 120, Broadway, New York, U.S.A.*

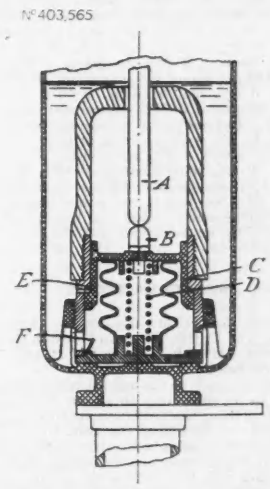
This invention relates to electric switches or circuit breakers of the kind in which the extinction of the arc formed on the separation of the contacts on load is carried out by a blast of vapour. The method of operation of these switches may either be such that the vapour is supplied from an external source, or is produced in the switch itself by a heating device or similar auxiliary means. In either case, the vapour is caused to flow between the contacts when they are separated and extinguishes the arc by its blowing and cooling action. In order to protect the surroundings from the exhausting vapour, it has been proposed to provide means for collecting the vapour; but a considerable counter-pressure is often produced and impairs the extinguishing action of the vapour at the contacts. According to the invention, this disadvantage is eliminated by providing a condensation device for the exhausting vapour adapted to increase the velocity of the vapour at the contacts directly behind the point of interruption. A centrifugal action on the



vapour flowing away is brought about by the spirally wound form of the exhaust pipe A, and this action favours the separating out of the liquid from the vapour, and, moreover, improves the condensation, inasmuch as the vapour is brought into direct contact with the walls of the exhaust tube. In order to prevent the condensate from flowing back into the switch, conical rings B are provided, which collect the condensate and permit it to flow away into channels or pipes.—*December 28th*, 1933.

403,565. May 17th, 1933.—OIL-BREAK SWITCHES AND THE LIKE, Ateliers de Constructions Electriques de Charleroi, of 91, rue de l'Enseignement, Brussels.

A scheme is described in this specification for increasing the rupturing speed of an oil switch. At the opening of the switch, the movable contact rises, and is followed in its movement by the contact B and the piston C owing to the action of the spring D. This movement of the piston and contact B continues up to the moment when the annular stop E brings it to rest. The

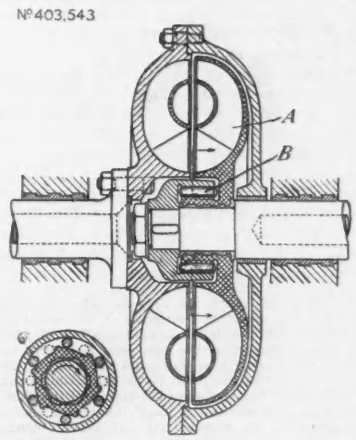


separation of the contacts A and B then gives rise to an arc, and, in consequence of the gaseous pressure produced in the rupture chamber, the piston C is driven back very rapidly, thus compressing the spring D until its movement is arrested by the stop F. The downward movement is extremely rapid, owing to the low inertia of the parts, so that the arc-rupturing distance increases considerably at the moment of the separation of the contacts A and B. After the extinction of the arc, the piston C is returned by the spring D against the stop E.—*December 28th*, 1933.

TRANSMISSION OF POWER.

403,543. March 14th, 1933.—HYDRAULIC COUPLINGS, G. Bauer, Mittelweg 82, Hamburg, Germany, and C. Schmieske, Wangeroogerstrasse 12, Bremen, Germany.

This invention is concerned with the coupling of several



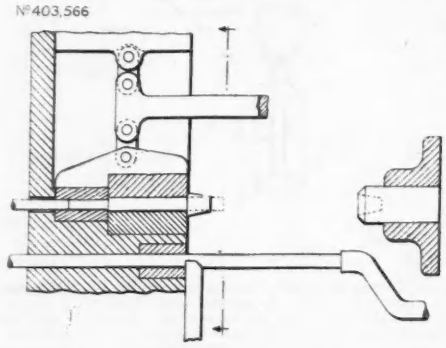
power units to one driven member by hydraulic couplings. In the event of a coupling being "opened," there will, normally, be a loss on account of the churning of the water in the coupling. This trouble is overcome by mounting the driven member A

of the coupling on a free-wheel device B, so that the driven shaft can over-run the driver, if it should be driven, by the other power units, at a greater speed than that of the unit in question without dragging round the impeller of the coupling.—*December 28th*, 1933.

MACHINE TOOLS AND SHOP APPLIANCES.

403,566. May 18th, 1933.—BOLT HEADING MACHINES, W. L. Clowse, Tiffin, Ohio.

For the purpose of making rolled thread bolts it is sometimes desirable to make the blank with the portion that will be threaded of a smaller diameter than the shank, so that the ultimate diameter of the thread will increase to that of the shank. If blanks more than five diameters long are required it is necessary to use split dies in the heading machine. To the rear of the split die



there is a solid die of smaller bore, into which that part of the bolt which is to be threaded is extruded. The chief claim in the specification is for the arrangement of the closing gear for the dies. This is operated by a toggle and acts both to clamp together the two halves of the split die and to hold the solid die in place. In this way it is assured that when the closing pressure is released the two dies will remain in line and the ejector can drive out the finished blank.—*December 28th*, 1933.

METALLURGY.

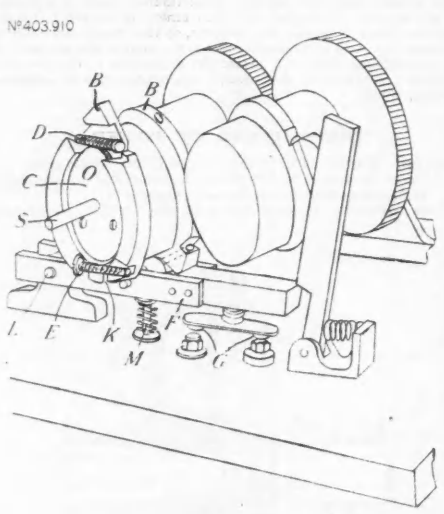
403,806. December 14th, 1932.—NON-SCALING STEEL, H. J. Schiffler, Am Binnenwasser 14, Düsseldorf, Germany.

The inventor makes a claim for a steel (1) containing about 2% chromium, 0·4% aluminium, 0·35% silicon, 0·6% molybdenum, 0·05% carbon, 0·25% tungsten, 0·3% manganese; (2) a steel containing about 3½% chromium, 0·2% aluminium, 0·2% silicon, 0·3% molybdenum, 0·10% carbon, 0·54% copper, 0·6% tungsten, 0·35% manganese, and the balance principally iron. Instead of the mentioned copper content, it is also possible to use 0·54% cobalt or 0·54% nickel. (3) A steel containing about 4·0% chromium, 0·5% aluminium, 0·35% silicon, 0·5% molybdenum, 0·10% carbon, 0·25% manganese, 0·13% zirconium. Such a steel, he says, has a yield point of 23·6 kg./mm.², and a breaking point of 56·0 kg./mm.² at a temperature of 400 deg. Cent., and corresponding strengths of 20·5 kg./mm.² and 40·8 kg./mm.² at 600 deg. Cent.—*January 4th*, 1934.

MISCELLANEOUS.

403,910. August 15th, 1933.—MEANS FOR ATTACHING CAMS TO SHAFTS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2, and S. N. Bourne, Birdingbury, Rugby.

For some services, such as the operation of electrical switches, it is necessary to be able easily to adjust the angular position of a cam on its driving shaft. The inventors suggest that the means employed for attaching the cam to its shaft should comprise a worm wheel attached to the shaft, a split cam ring surrounding the worm wheel, an adjusting screw in the split cam ring engaging with the teeth of the worm wheel and used for altering the relative position of the cam ring and worm wheel, and also serving as a positive lock between the two, and a locking screw for clamping the cam ring to the worm wheel. The cam ring B is fixed to a worm wheel C, which is attached



to a shaft S, so as to permit of a very fine adjustment between the cam B and the wheel C, by means of the worm screw D, and is then locked definitely by a locking screw E. It will be seen from the drawing that the cam ring B is split at K, so that as the locking screw E is tightened the teeth of the worm wheel C are forced into the teeth of the adjusting worm screw D to give a positive lock between the cam and the shaft. The tightening of screw E also causes the two halves of the cam ring to grip tightly on to the wheel C, so that the combination produces not only a good friction drive, but one in which there is a positive locking between the two parts. In the particular case shown in the diagram, the cam is shown as operating the electrical contacts G attached to the contact bar F pivoted at L, and the spring biased against the cam ring by the spring M.—*January 4th*, 1934.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF METALS: SHEFFIELD LOCAL SECTION.—In Applied Science Dept., The University, Sheffield. "Recovery and Refining of Precious Metals," Mr. H. G. Dale. 7.30 p.m.

INST. OF PRODUCTION ENGINEERS: WESTERN SECTION.—At Merchant Venturers' College, Bristol. "Psychological Aids to Increased Production." Dr. G. H. Miles. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Honorary Member's Lecture, "Thunder Storms, Magnetic Storms, and Wireless Transmission," Professor E. V. Appleton, F.R.S. 7.30 p.m.

KEIGHLEY ASSOC. OF ENGINEERS.—Queen's Hotel, Keighley. "Recent Developments in Cast Iron and Foundry Practice," Mr. F. K. Neath. 7.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—In Mining Inst., Newcastle-upon-Tyne. "Auxiliaries for Marine Engine Installations," Mr. P. L. Jones. 6 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, "Reminiscences of Physics and Physicists," Sir Joseph Thomson. 9 p.m.

SATURDAY, FEBRUARY 10TH.

INST. OF MARINE ENGINEERS (JUNIOR SECTION).—85/88, The Minories, E.C.3. Social and dance. 7.30 p.m. to 11.15 p.m.

MONDAY, FEBRUARY 12TH.

INST. OF ELECTRICAL ENGINEERS: N.-EASTERN CENTRE.—Armstrong College, Newcastle-upon-Tyne. "Influence of the Benson Boiler on the Development of Power Stations," Dipl.-Ing. F. Ohlmuller. 7 p.m.

INST. OF METALS: SCOTTISH LOCAL SECTION.—At 39, Elmbank-crescent, Glasgow. "Combustion Efficiency," Mr. J. A. C. Edmiston. 7.30 p.m.

INST. OF TRANSPORT.—Joint meeting with Inst. of Electrical Engineers, Savoy-place, W.C.2. "Regeneration as Applied to Electric Traction," Mr. G. F. Sinclair. 5.30 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2.—Thomas Gray Lecture, "Deep Diving and Under-water Rescue," Sir Robert H. Davis. 8 p.m.

TUESDAY, FEBRUARY 13TH.

INST. OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH: BURNLEY SECTION.—At Municipal College, Burnley. "Iron-foundry Practice Modernised," Mr. R. H. C. Weeks. 7.30 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Papers further discussed on "The Water Supply of Kano, Northern Nigeria," Harold John Frederick Gourley, M. Eng., M. Inst. C.E., and "Uniform Flow in Alluvial Rivers and Canals," Gerald Lacey, B.Sc., Assoc. M. Inst. C.E. 6 p.m.

INST. OF ELECTRICAL ENGINEERS.—Joint meeting with Inst. of Fuel, at Engineers' Club, Manchester. "Influence of the Benson Boiler on the Development of Power Stations," Dipl.-Ing. F. Ohlmuller. 7 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Some Influence on a Shipowner's Choice of a New Cargo Ship," Messrs. R. R. Campbell and B. Ramsay. 7.30 p.m.

INST. OF MARINE ENGINEERS.—The Minories, E.C.3. "Turbo-electric Propulsion," Mr. C. Wallace Saunders. 6 p.m.

INST. OF METALS: BIRMINGLAM LOCAL SECTION.—At James Watt Memorial Inst., Birmingham. "Age-hardening Copper Alloys," Dr. Maurice Cook. 7 p.m.

INST. OF METALS: NORTH-EAST COAST LOCAL SECTION.—At Armstrong College, Newcastle-upon-Tyne. Annual general meeting. Chairman's Address. 7.30 p.m.

INST. OF PETROLEUM TECHNOLOGISTS.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "Chemical Evidence for Low-temperature History of Petroleum." Dr. B. T. Brooks. 5.30 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-st., Sheffield. "Scientific Training in Industry," Mr. J. R. Clarke. 7.30 p.m.

WEDNESDAY, FEBRUARY 14TH.

BRITISH STEELWORK ASSOC.—At Inst. of Structural Engineers, 10, Upper Belgrave-street, S.W.1. "The Technical and Economic Aspects of Welded Steel Structures," Dr. Ing. Hans Schmuckler (of Berlin). 6.45 p.m.

DIESEL ENGINE USERS ASSOC.—Caxton Hall, S.W.1. "Piston Design and Material," Mr. H. J. Maybrey. 3 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Informal Meeting. Discussion, "Methods of Dealing with Flood Discharges of Rivers," Mr. W. N. McClean. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: N.-EASTERN CENTRE.—At Literary and Philosophical Soc., Westgate-road, Newcastle-upon-Tyne. Faraday Lecture, "The Electrical Engineer and the Free Electron," Mr. Clifford C. Peterson. 7 p.m.

INST. OF ENGINEERS-IN-CHARGE.—St. Bride Institute, Bride-lane, E.C.4. "Photo-cells and their Application," Mr. R. C. Walker. 7.30 p.m.

INST. OF HEATING AND VENTILATING ENGINEERS.—12, Russell-square, W.C.1. Council meeting, 10.15 a.m., at London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1; annual general meeting, Presidential Address, Mr. R. C. Ching; paper, "Infra-red Rays and Comfort," Sir Leonard Hill, F.R.S., 2 p.m.; Hotel Russell, Russell-square, W.C.1, annual dinner, 6.30 for 7 p.m.

INST. OF SANITARY ENGINEERS.—Caxton Hall, S.W.1. "The Inevitable Trend of Sewage Treatment," Mr. N. Campbell Little. 6 p.m.

INST. OF STRUCTURAL ENGINEERS: LANCS. AND CHESHIRE BRANCH.—Engineers' Club, Manchester. "The Constructional Aspects of Large Generating Stations," Mr. A. C. Dean. 7 p.m.

INST. OF WELDING ENGINEERS.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Welding as Applied to Ship Construction and Repair," Mr. S. E. Evans. 7.45 p.m.

THURSDAY, FEBRUARY 15TH.

INST. OF ELECTRICAL ENGINEERS.—Joint meeting with Inst. of Fuel. Inst. of Mechanical Engineers, Inst. of Marine and Junior Inst. of Engineers. At Savoy-place, Victoria Embankment, W.C.2. "Influence of the Benson Boiler on the Development of Power Stations," Dipl.-Ing. F. Ohlmuller. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND CENTRE.—At Albert Hall, Cookridge-street, Leeds. Faraday Lecture, "The Electrical Engineer and the Free Electron," Mr. Clifford C. Paterson, 7.30 p.m.

INST. OF FUEL.—At University College, Nottingham. "The Aims and Organisation of the Coal Utilisation Council," Mr. W. R. Gordon. 7 p.m.

INST. OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W.1. "Methods of Producing Artistic Surfaces in Concrete," Mr. T. Wallis. 6.30 p.m.

N.-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS: TEES-SIDE BRANCH.—At Cleveland Scientific and Technical Inst., Middlesbrough. "Recent Advances in Electric Welding," Dr. J. H. Paterson. 7.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. "Elements of Crystal Analysis," Sir William Bragg, F.R.S. 5.15 p.m.

FRIDAY, FEBRUARY 16TH.

INST. OF CHEMICAL ENGINEERS.—Hotel Victoria, Northumberland-avenue, W.C.2. Twelfth Annual Corporate Meeting. Presentation of Medals. Presidential Address, "Chemical Engineering and the Edible Fat Industry," 11 a.m. "Modern Methods of Attacking Heat Transmission Problems," Prof. C. H. Lander, 2,15 p.m. Twelfth annual dinner, 7 p.m., for 7.30 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Annual general meeting. Discussion, "Some Factors in the Design of Surface Condensing Plant," Messrs. H. L. Guy and E. V. Winstanley. 5.30 p.m.

INST. OF STRUCTURAL ENGINEERS: WESTERN COUNTIES BRANCH.—At Merchant Venturers' Technical College, Bristol. "Application of the L.C.C. Code of Practice," Mr. C. H. Williams. 7.15 p.m.

INST. OF TRANSPORT.—At Connaught Rooms, Great Queen-street, W.C.2. Annual dinner. 6.30 p.m. for 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Clarification of Polluted Water with Particular Reference to Colliery Wastes and Sewage," Dr. R. D. Gifford. 7.30 p.m.

MANCHESTER ASSOC. OF ENGINEERS.—Engineers' Club, 17, Albert-square, Manchester. Annual dinner. Reception, 6.45 p.m.; dinner, 7.15 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, "Surface Tension," Mr. Allan Ferguson. 9 p.m.

SATURDAY, FEBRUARY 17TH.

INST. OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Engineers' Club, Manchester. "Production of Specially Hard Cast Irons by Alloying and Heat Treatment," Mr. W. T. Griffiths. 4 p.m.

INST. OF CIVIL ENGINEERS.—Students' Visit to Dagenham works of Samuel Williams and Sons, Ltd. Afternoon.

MONDAY, FEBRUARY 19TH.

ENGINEERS' GERMAN CIRCLE.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Schnelltriebwagen der Deutschen Reichsbahn (Fast Rail-cars on the German State Railways)," and "Mit dem Fliegenden Hamburger von Hamburg nach Berlin (With the Flying Hamburger from Hamburg to Berlin)," illustrated with kinema films, by a Technical Expert from the Deutsche Reichsbahn Gesellschaft (German State Railways). 6 p.m.

INST. OF AUTOMOBILE ENGINEERS.—At Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow, C.2. "Aero Engine Design," Capt. G. S. Wilkinson. 7.30 p.m.

INST. OF MECHANICAL ENGINEERS: GRADUATES' SECTION.—Storey's-gate, S.W.1. "Temperature Control as Applied to General Refrigeration," Mr. F. H. Slade. 6.45 p.m.

INST. OF STRUCTURAL ENGINEERS: JUNIOR MEMBERS.—10, Upper Belgrave-street, S.W.1. "Building Practice in its Various Aspects." 6.45 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2.—Thomas Gray Lecture, "Deep Diving and Under-water Rescue," Sir Robert H. Davis. 8 p.m.

TUESDAY, FEBRUARY 20TH.

ILLUMINATING ENGINEERING SOC.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Heterochromatic Photometry," Mr. H. Buckley. 7 p.m.

INST. OF AUTOMOBILE ENGINEERS.—Victoria Hotel, Wolverhampton. "Body Design for Public Service Vehicles," Mr. A. J. Romer. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND CENTRE.—Hotel Metropole, Leeds. "The Application of Automatic Voltage and Switch Control to Electrical Distributing Systems," Messrs. W. Kidd and J. L. Carr. 7 p.m.

INST. OF METALS: SWANSEA LOCAL SECTION.—At Y.M.C.A., Swansea. "Cracking and Fracture of Metals with Special Reference to Service Breakages," Professor F. Bacon. 6.15 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield. "Recent Developments in the Foundry Industry," Mr. V. C. Faulkner. 7.30 p.m.

WEDNESDAY, FEBRUARY 21ST.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN STUDENTS.—County Hotel, Newcastle-upon-Tyne. Annual dinner. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND CENTRE.—At James Watt Memorial Inst., Birmingham. "The Effective Use of Coal," Prof. R. V. Wheeler. 6 p.m.

INST. OF FUEL.—At Engineers' Club, Manchester. "Pulverised Coal," Commander H. D. Tollemache. 7 p.m.

INST. OF STRUCTURAL ENGINEERS: SCOTTISH BRANCH.—129, Bath-street, Glasgow. "Water Ratio Rules and their Limitations," Mr. W. Hunter. 7.30 p.m.

THURSDAY, FEBRUARY 22ND.

INST. OF FUEL.—St. Ermin's Hotel, Caxton-street, S.W.1. Discussion, "Should Large Coal be Crushed to Meet the Increasing Demand for Smalls?"

INST. OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W.1. "Metallic Materials of Construction," Dr. W. Rosenhain. 6.30 p.m.

FRIDAY, FEBRUARY 23RD.

INST. OF MARINE ENGINEERS.—Grosvenor House, Park-lane, W.1. Annual dinner. 7 p.m.

INST. OF STRUCTURAL ENGINEERS: MIDLAND COUNTIES BRANCH.—James Watt Memorial Inst., Birmingham. "Application of Scale Models to Engineering Design," Mr. John Dosser. 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1.—"Some Modern Improvements in Electrical Instruments," Mr. G. F. Shotter. 7.30 p.m.

RAILWAY CLUB.—At Royal Scottish Corporation Hall, Fetter-lane, E.C.4. Annual general meeting. Presidential address, "Plymouth and Dartmoor Railway," Mr, Kenneth Brown. 7.30 p.m.

MONDAY, FEBRUARY 26TH.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND CENTRE.—At The University, Birmingham. "Applications of Automatic Voltage and Switch Control to Electrical Distribution Systems," Messrs. W. Kidd and J. L. Carr. 7 p.m.

TUESDAY, FEBRUARY 27TH.

DIESEL ENGINE USERS ASSOC.—At Pagani's Restaurant, 42/49, Great Portland-street, W.1. Annual dinner, 7 for 7.30 p.m.

INST. OF STRUCTURAL ENGINEERS: LANCS. AND CHESHIRE BRANCH.—At Liverpool Engineering Soc., Liverpool. "Foundations," Mr. G. B. R. Pimm. 7 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield. "Manufacture of Sand Spun Pipes," Mr. J. B. Allan. 7.30. p.m.

A Seven-Day Journal

The Electrical Research Association.

AT the annual luncheon of the British Electrical and Allied Industries' Research Association, held at the Savoy Hotel on Friday, February 9th, the President, Sir Hugo Hirst, dealt with the question of whether research pays. Although the question could not be answered with figures, there was no doubt that research brought prestige and confidence which resulted in business. No country had a better record than this in the field of invention, and he was confident that with encouragement men would be found to lead it again to the forefront. In the home trade, at all events, there was now a gradual improvement, but sonner or later the saturation point must be reached. What was needed was more export business, and he saw in the E.R.A. the basis of a chance for Great Britain's future leadership among the industrial nations of the world. In a Foreword to the Association's annual report, which has now been in our hands for some little time, Mr. C. C. Paterson explains that the Association's facilities for answering questions are now not equal to the questions that are being legitimately put. In other words, the Association is still in need of more funds. Nevertheless, a glance through the items of the programme of work contained in the report shows that a large amount of very useful work has been done, both in connection with the heavy and lighter branches of electrical engineering. As in previous years, preference was given to the continuance of work already undertaken, and to the beginning of new researches only if urgently required.

German Electrical Export Trade.

THE annual reports of two of the leading electrical manufacturing firms in Germany, representing the low-tension and high-tension branches respectively, contain statements which appear to be of particular interest to all makers who have to meet German competition in the markets of the world. In the case of the Siemens and Halske Company, the directors state that the export trade in the past financial year experienced a further decline, although this diminution was partly compensated by the improvement in the inland turnover. In the opinion of the board, the company will have to reckon with a further decrease in the foreign business, as the difficult economic conditions in most importing countries have now become aggravated by the establishment of national electrical industries and through the depreciation of currencies. The directors of the Siemens-Schuckert Works state that, as compared with the improvement in the home market, the conditions in the export trade were less favourable, but it appeared as if the world economic crisis had passed the lowest point, and an increase in the requirements was being manifested in various countries. The price level has further declined, owing to the fight which the world electrical industry is carrying on in the export trade. This is felt in a specially great measure by the German electrical industry with its high costs of production and taxes. The directors consider that the recovery in the home market should form the basis for a strong development of the export trade, and it is held to be quite time for effective support to be given in official circles to the export trade.

The Thames Reservoirs.

AT a meeting of the Thames Conservancy Board, held in London on Monday, February 12th, the Chairman, Lord Desborough, stated that so far as the Board was concerned, there was no immediate shortage of water or cause for alarm. He understood that at the present time all the Board's reservoirs were full. Rain was still needed, for if we had another dry summer, there would, he said, be little to fall back upon. Up to the present, reports showed that the tributaries of the Thames were keeping up very well. The month of December had been a very dry one, and the rainfall in the Thames catchment area was only 0·48in., compared with the standard average of 2·99in. The total rainfall in the area for the six months from July 1st last was 8·90in., which was the lowest in the records of the Board over the fifty-one years during which they had been kept. The deficiency in rainfall in the Thames area over the six months referred to was, Lord Desborough stated, equal to 413,000 million gallons, or 1800 million tons, which was equivalent to a body of water about 2500 miles long, having a width of 250ft. and a depth of 10ft. The daily flow of the river was now only 500 million gallons, compared with 2399 million gallons, the standard daily flow for February.

Euston House.

ON Monday last the new offices of the L.M.S. Railway Company at Euston House, Seymour-street, adjacent to Euston Station, were formally opened by Mr. Oliver Stanley, the Minister of Transport. Sir Josiah Stamp, who presided, welcomed the Minister as a member of a family which had a long and remarkable record of associations with the old Midland Company. Mr. Oliver Stanley congratulated the L.M.S. Railway Company on its courage and enterprise in undertaking the construction of a new office building at a cost of about £150,000 during a time of deep depression. Wishing all the railways success in their development plans, the Minister said that he had tried to do all that he could to assist both rail and road transport impartially, in order to give the public the cheapest and most efficient forms of transport available. From all that he had heard from all over the country, there was to-day new life, hope, and enterprise in industry, and a readiness to face the future with confidence. Euston House marks a notable addition to the architectural improvements which are gradually altering the appearance of the area around the North London railway termini. It has ten floors, and will house the hitherto scattered staff, numbering some 1300, of the commercial, operating, signal, telegraph, and store purchase departments, thereby enabling the company to concentrate its engineering, secretarial, finance, and estate departments in the old Euston buildings. The new building is constructed on the steel frame principle, and has a spacious central court.

Destroyers for South America.

ON more than one occasion we have referred in our columns to the destroyers for the Portuguese Government which have been constructed at Scotstoun by Yarrow and Co., Ltd., and the sister ships built to their design and under their supervision at the Lisbon dockyard. According to *The Times'* correspondent in Portugal, the two Lisbon-built destroyers, the "Tejo," which recently underwent successful trials, and the "Douro," now under construction, have been handed to Messrs. Vickers for sale to the South American Republic of Colombia. It is understood that the Colombian Government originally expressed the wish to purchase the Yarrow-built destroyer "Lima," which, it may be recalled, was illustrated and referred to in our issue of January 5th, but the Portuguese Government would only sell the two Lisbon-built destroyers. The keels will shortly be laid at Lisbon for the building of two new destroyers to take the place of those sold, which work, it is expected, will give employment to some thousand men over a period of eighteen months. The new destroyers will, we assume, also be built to Yarrow designs, and like the previous ships be engined with Yarrow-built turbines and boilers. As recorded in our January 5th issue, Vickers-Armstrongs are now completing three Portuguese destroyers of 854 tons displacement.

The French Line.

WE are informed by the Compagnie Générale Transatlantique, Ltd., of London, the agents for the British Isles of the Compagnie Générale Transatlantique, of Paris, that the new board of the parent company has decided to appoint Monsieur Pierre de Malglaive, of Paris, as resident director in London. Monsieur de Malglaive, who will shortly become managing director of the London company, has had long experience in European and American shipping circles, and is a well-known figure at international shipping conferences. His long residence in America as the C.G.T. Representant-General for the Continent of America, has given him a close understanding of Anglo-Saxon and American character, and he will be particularly welcome to British people to whom he is attached by family ties. The appointment is a graceful recognition by the French company of the importance of London in the international shipping world, and an indication of the importance of its British interests. Monsieur de Malglaive will succeed Monsieur P. C. V. Le Brun, the present managing director, who, having passed the age limit prescribed by regulations, will retire from active representation of the French Line, which he has served for twenty-four years. Mr. G. C. Rhodes will continue to be in charge of the London agency of the French Line.

Road Transport Safety.

IN the course of a speech made at the annual dinner of the North Regional Area Road Haulage Association, which took place at Newcastle-upon-Tyne, on Saturday, February 10th, Lieut.-Colonel Cuthbert Headlam, Member of Parliament for the Barnard Division and Parliamentary Secretary to the Ministry of Transport, said that the Government was determined to stop the terrible toll of the roads, and was asking for the close co-operation of local authorities, motor vehicle manufacturers, Safety First Associations, and, above all, the public, in solving the safety problems connected with transport on our roads and in our big cities. The Government proposals, Lieut.-Colonel Headlam went on to say, would include countrywide propaganda to teach the public road-sense, special paths for pedestrians across public streets, lines on roads to control overtaking traffic, special tracks for cyclists, improving the camber of roads and making surfaces non-skid, the strengthening of weak bridges, the improvement of visibility on roads, and the removal of bad corners. With regard to the strengthening of weak bridges, the Minister of Transport is not, it would appear, prepared to contemplate any prolonged delay in bringing the provisions of Sec. 30 of the Road and Rail Traffic Act, 1933, into operation, and the Minister has recently sent a circular letter to County Clerks in England, Scotland, and Wales stressing the immediate importance of their sending in "priority lists" of bridges requiring strengthening or reconstruction, with an indication of the degree of urgency, and a statement as to how far the use of such bridges can be avoided by the use of alternative routes. In the early part of this week two deputations were received by the Ministry of Transport which urged the importance of proceeding as quickly as possible with the reconstruction of weak and dangerous road bridges. They were from the British Steelwork Association and the British Road Federation.

The Yorkshire Electric Power Company.

THE report of the Yorkshire Electric Power Company, which is to be presented at the annual general meeting, to be held in Leeds on Tuesday, February 20th, shows that the sale of electricity to consumers increased from 215,156,631 units in 1932 to 235,902,400 units in 1933, and, in addition, 143,704,843 units were supplied last year to the Central Electricity Board. Since January 1st, 1933, the company's three generating stations have been operated in accordance with the provisions of the Electricity (Supply) Act, 1926. The recent improvement in trade and manufacture has resulted in an increased demand for electricity, particularly by the textile trades and general power users; while there have been further increases in the supplies in bulk to authorised undertakers. During last year the company's system was extended to meet increasing demands from consumers, and the generating stations were more fully employed. In Lincolnshire temporary provision has been made for a bulk supply to Barton-upon-Humber and the construction of the necessary system of mains and sub-stations is proceeding for the supply in the area under the North Lincolnshire and Howdenshire Electricity Special Order, 1932. In December last a supply of electricity was made available to consumers for the first time in Lincolnshire at Winterton and Brigg. The net profits for 1933 were increased by £66,891, compared with 1932.

The Late Sir William Raeburn, Bart.

IT is with regret that we have to record the death of Sir William Hannay Raeburn, which took place at his home at Helensburgh, Dumbartonshire, on Monday, February 12th. Sir William, who was in his eighty-fourth year, was born in Glasgow, and in 1873 became a partner in the shipping business of Dunn and Raeburn, which afterwards took the name of Raeburn and Verrel. His firm managed the Monarch Line of steamships, and as head of that line and a prominent member of the Chamber of Shipping, Sir William Raeburn was looked upon as one of our leading shipowners. He was President of the Chamber of Shipping in 1916 and the following year, and was also closely connected with the development of the British Corporation Register of Shipping and Aircraft and one of its founders. The port of Glasgow owes much to his vision and foresight. As a member of the Clyde Navigation Trust for over forty years, and its Chairman for ten years, he did much to place the Clyde in the position it holds among British ports. The Shieldhall Dock is a monument to his services to the Trust. His parliamentary work was also important, and for many years he was a member of the Shipowners' Parliamentary Committee and did much to further the welfare of British shipping. In 1926 he was President of the Docks and Harbours Association.

Shipbuilding on the Tyne.

ON Tuesday, February 13th, the First Lord of the Admiralty, Sir Bolton Eyres Monsell, received a deputation of Members of Parliament representing Tyneside areas, which made representations with regard to the North-East Coast shipbuilding industry. The deputation urged that, in view of the very serious unemployment on the Tyne and disastrous national consequences of allowing skilled shipbuilding craftsmen, through unemployment, to lose their skill, the Admiralty should do its best to allocate some work to the Tyne area. In the course of his reply the First Lord of the Admiralty expressed the deep sympathy which he felt with the shipbuilders of the Tyne in the distress from which they were at present suffering, and his sense of the great debt which this country owed to the shipbuilding industry. No one realised more than the Admiralty how vitally we depended upon our skilled shipbuilders, and how deplorable it would be if, through lack of employment, their skill became lost to us. He explained, however, that, so far as the Admiralty was concerned, the amounts of the competitive tenders were necessarily the principal consideration in the allocation of orders. He added, however, that the Admiralty would welcome an even distribution of future work. During the past week several new shipbuilding orders have been received on the Tyne. Swan, Hunter and Wigham Richardson, Ltd., will build a further Commonwealth and Dominion Line motor ship, similar to the "Port Chalmers," which will be propelled by Wallsend-Sulzer oil engines. Orders for smaller steamships have been received by Hawthorn, Leslie and Co., Ltd., and S. P. Austin and Son, of Sunderland.

The Development of the Parsons Steam Turbine.

No. VII.

(*Continued from page* 142, *February 9th*).

The First Carville Turbines.

SHORTLY after the tests above referred to, the two 1500-kW turbines were removed from the Neptune Bank station to a new station constructed by the Newcastle-on-Tyne Electric Supply Company at Carville, the Neptune Bank station then falling into disuse. It may be mentioned that these two machines, after several years' service at Carville, were again removed and re-erected in the Philadelphia station of the same company, in order to make room for larger units at Carville. The first new generating set built for the Carville station was a unit of nominally 3500 kW capacity, the order for which was placed in 1903. Being of more than double the capacity of any turbo-generating set constructed up to that time, it marked another important step in the development of turbine machinery. The turbine was of the single-cylinder, single-flow type, designed to give its rated output at 1200 revolutions per minute, and to work with steam at 200 lb. pressure, and a temperature of 540 deg. Fah. The design was a very liberal one; indeed, unduly so, for the machine proved itself capable of carrying loads up to 6000 kW for considerable periods, its economical load being substantially higher than that for which it was rated. The fault, however, if it is fair to use such a word, was on the right side, for not only would the set do more than it was guaranteed to do, but it gave such satisfaction that, with its successors, it made Carville for many years the most economical power station in the world.

The set in question was made the subject of very careful tests, carried out in February, 1905, by Mr. Charles H. Merz, the consulting engineer to the Newcastle-upon-Tyne Electric Supply Company. The steam consumption was obtained by weighing the condensate, and every precaution was taken to ensure accuracy, all instruments being calibrated both before and after the tests. A summary of the results is given in Table III.

TABLE III.—*Steam Consumption Tests of First* 3500 *kW Turbo-alternator at Carville Power Station, February 5th*, 1905.

Test No.	Duration.	Aver. load, kW.	Steam.		Speed, r.p.m.	Vacuum at turb. exhaust, in. Hg.	Steam cons., lb./kWh.
			Press. gauge, lb./in.².	Temp. at stop v., deg. Fah.			
1	20 min.	5801	191·6	509·2	1190	28·0	16·46
2	60 min.	4931	194·4	529·9	1200	28·6	15·87
3	60 min.	4142	199·1	530·3	1200	29·0	15·40
4	60 min.	2108	203·8	534·8	1198·2	29·5	16·56
5	30 min.	No load, excited	205·7	477·0	1229	29·6	—
6	30 min.	No load, unexcited	206·3	444·5	1235·5	29·7	—
7	20 min.	5685	192·8	529·2	1203	28·14	15·94

N.B.—During the tests the barometric pressure was 30·25in. Hg.

The most economical load of the unit, as will be seen from the table, was about 4000 kW, when a steam consumption of 15·4 lb. per kWh was recorded. Although then working at 14 per cent. above its rated output, the pressure at the turbine exhaust was maintained within an average of 1·25in. of a perfect vacuum, a feat which bears tribute to the efficiency of the condensing apparatus. The air pumps were of the reciprocating type, dealing with both condensate and air, but the excellence of their performance must be ascribed to the vacuum augmentor, then recently invented by Mr. Parsons. This apparatus will be described fully in connection with condensing plant, so that it is sufficient to say here that it was the direct parent of the steam jet air pump in universal use to-day.

A photograph showing the general appearance of the 3500 kW unit is reproduced in Fig. 44, while Fig. 45 illustrates the turbine in section. The rotor, as will be remarked, consisted of a hollow steel forging with stub end shafts, the shaft at the low-pressure end being carried on an open spider. The three diameters of the rotor were balanced as to end thrust by three dummy pistons of corresponding diameters, while the rotor was located and any residual axial pressure taken by a multi-collar thrust block at the high-pressure end. Between this thrust block and the bearing was a worm which engaged with a worm wheel on a transverse shaft above. This shaft terminated in flanges fitted at one end with a crank pin from which the oil pump was driven, and at the other end with a cam which served to provide the reciprocating motion required for the governor gear.

Two centrifugal governors were driven by bevel gearing from the cross shaft. One of these controlled the speed of the turbine by means of the relay mechanism shown in Fig. 45, while the other governor had no other function than to trip the emergency valve in the event of a predetermined overspeed being exceeded.

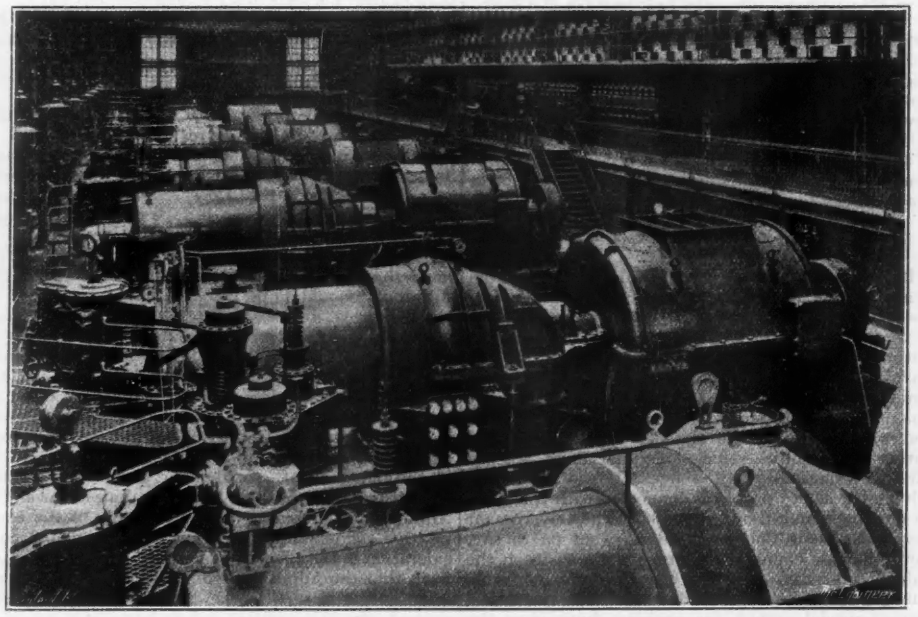


FIG. 44—THE CARVILLE POWER STATION, WALLSEND-ON-TYNE, 1907

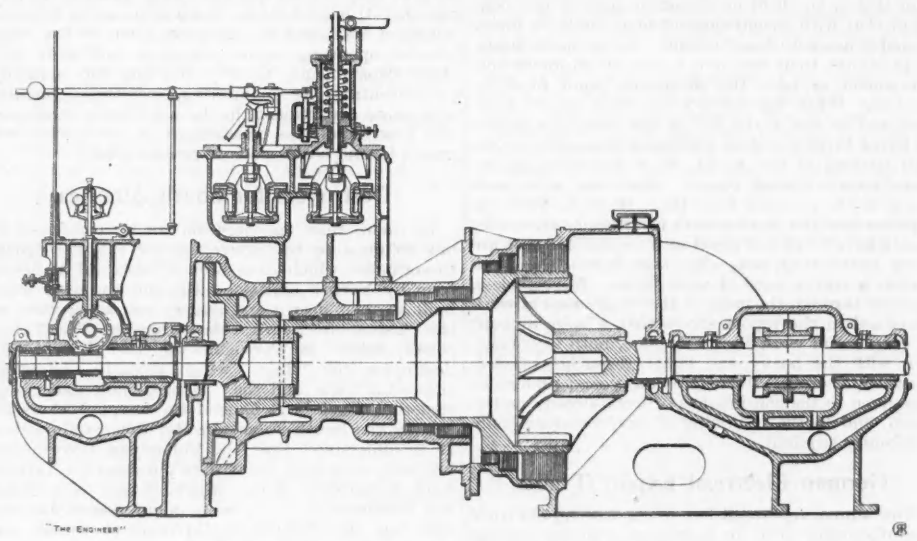


FIG. 45—SECTION THROUGH CARVILLE TURBINE

The steam chest was fitted at the top of the cylinder, and contained three valves. The entering steam passed first through the emergency valve, which was operated by the action of a suspended weight as described in the case of the Neptune Bank turbine. From the emergency valve the steam flowed to the main governor valve, and so to the interior of the turbine. These two valves are shown in section in Fig. 45. The third valve was the overload valve, which admitted live steam to the blades on the second drum of the rotor, thus by-passing the first thirty pairs of blade rows. Fig. 46 is a further section through the valve chest, taken to show the governor valve and the overload valve. The latter valve is the one at the right-hand side of the illustration. On its valve stem was a pair of pistons, of which the lower one had considerably the greater diameter. The space between the pistons was in constant communication with live steam, the differential pressure of which, aided by the spring at the top of the spindle, tended to keep the valve closed. Steam at the pressure existing in the by-pass belt was admitted to the space below the lower piston and tended to open the valve. As the load on the turbine increased, this pressure rose until it was sufficient to overcome the downward acting forces, and cause the valve to open, admitting live steam to the by-pass belt of the machine, and so permitting

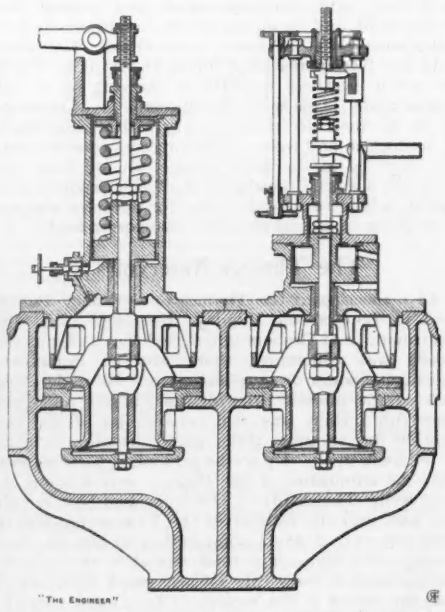


FIG. 46—SECTION THROUGH VALVE CHEST

an overload to be carried. The load at which the valve began to open was controlled by a small hand wheel, the turning of which varied the compression of the spring at the top of the valve spindle. The function of the lever shown engaging with the valve spindle was merely to enable the valve to be lifted by hand, and its freedom tested.

It appears from the drawings that when the by-pass valve was open it admitted live steam to the turbine directly. That is to say, the steam did not first pass through the governor valve. Hence, if the turbine were working on an overload and the load were suddenly decreased, there was a possibility of the speed rising unduly, supposing that for any reason the by-pass valve stuck and did not close promptly. In such an event, of course, the emergency valve would come into action, and shut off all steam from the machine, but the practice of allowing any steam uncontrolled by the governor to enter the turbine was soon abandoned as containing an element of risk. In subsequent designs no steam could be admitted to any part of the blading without having first passed through both the emergency stop valve and the governor valve.

A sectional drawing of the Carville alternator is reproduced in Fig. 47. The machine, which generated three-phase current at 40 cycles and 6000 volts between phases, was designed with a stationary armature, but did not embody the then new barrel type of rotating field magnets. The exciter was overhung on the end of the shaft. The stator was split horizontally for the sake of giving greater facility for the removal of the rotor, a feature since abandoned as being both unnecessary and involving a certain amount of complications of the end windings. Natural ventilation was at first relied on in this and subsequent machines of the type installed at Carville, but although under such conditions the alternators would do all and more than they were specified to do, it was very evident that more effective means of cooling were required to enable full advantage to be taken of the exceptional overload capacity of the turbines. The air could get away from the machines freely by means of the chimney opening at the tops of the stator casings, but its means of entry were inadequate. Hence openings were made in the undersides of the casings and ducts were led downwards to motor-driven fans in the basement. Air was thus forced through the alternators in a positive fashion, and the full overload capacity of the sets rendered available.

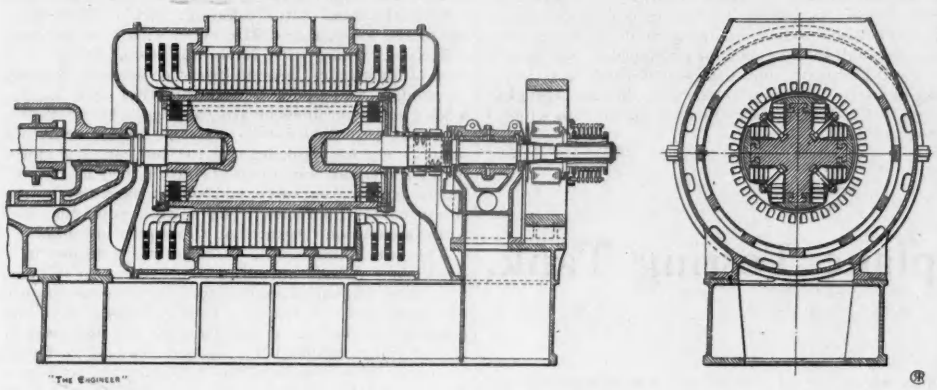


FIG. 47—THE CARVILLE ALTERNATOR

Between the years 1903 and 1906 six 3500-kW turbo alternators were supplied to Carville. They were all of substantially the same design, but in 1905 an improvement was effected in the third and subsequent machines by increasing the number of blade rows on the rotor from fifty-nine to seventy-one, the diameters and lengths of the blading remaining unaltered. Room was found for the twelve extra rows at the low-pressure end of the rotor by modifying the shape of the latter, no change in overall length being involved. The increase in the number of blade rows raised the Parsons coefficient "K" from 135 to 175, with a consequent increase in the efficiency.

TABLE IV.—*Steam Consumption Tests of 3500-kW Turbo-alternator at Carville Power Station, February 17th, 1907.*

Test No.	Duration.	Aver. load, kW.	Steam. Press. g., lb./in.².	Steam. Temp. at stop v., deg. Fah.	Speed, r.p.m.	Vac. at exh., baro. 30in.	Steam cons., lb./kWh.
1	30 min.	No load, not excited	180	460	1200	28·87	3670 lb. per hour
2	30 min.	No load, excited	211	453·3	1200	28·95	5206 lb. per hour
3	1 hour	2193	202·4	492·1	1200	29·04	14·517
4	1·5 hours	4045	197·4	495	1200	29·07	13·839
5	1·5 hours	5901	195·8	503·2	1200	28·95	13·464
6	30 min.	6922	198·4	505·5	1200	28·76	13·692
7	1 hour	5164	199·9	508·5	1200	29·04	13·189
8	3 hours	5059	194·5	477·9	1200	29·19	13·411

Although the significance of this coefficient "K" is well known to turbine designers, it may be well to give some explanation of it at this point. The efficiency of turbine blading depends upon what is called the "velocity ratio," which is the ratio between the blade speed and the velocity of the steam acting on the blades. In the case of reaction blading the most favourable velocity ratio approaches unity, but to secure such a ratio involves a very large number of stages in order to keep the steam speed low, or alternatively a very high blade speed. Since the velocity ratio of a compound reaction turbine depends upon a number of factors which the designer has to consider separately, it was found more convenient to group these in a formula by which various turbines could be compared irrespective of size, revolutions, or steam conditions. To this end the expression "K" was devised by Mr. Parsons. This expression is the integral of

$$\frac{(\text{Mean diameter})^2}{10} \times \frac{(\text{R.p.m.})^2}{100}$$

throughout the turbine, the mean diameter being measured in inches. If this is evaluated for any particular turbine and divided by the total thermodynamic head corresponding to the particular steam conditions, the square root of the quotient is directly proportional to the velocity ratio of the machine. The correlation between a large "K" and a high efficiency of the turbine will thus be evident.

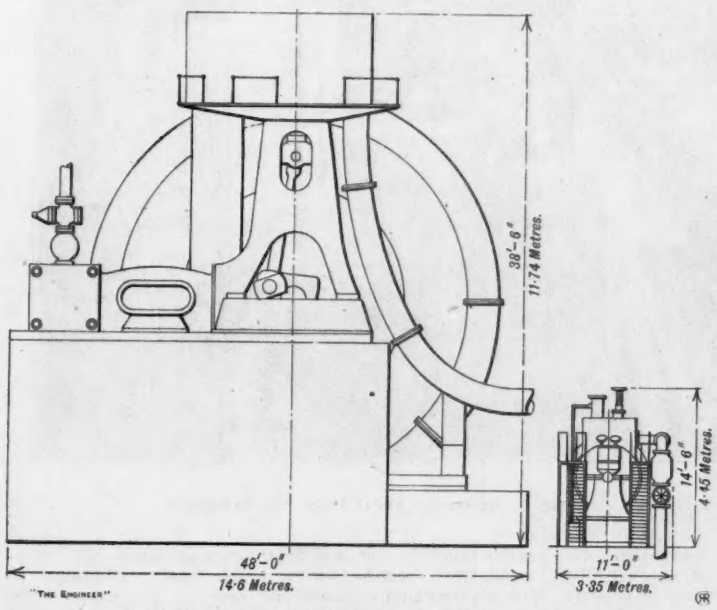


FIG. 48—RELATIVE DIMENSIONS OF RECIPROCATING SET AND TURBO-ALTERNATOR

The improvement brought about by the alteration of the blading, referred to above, is evident by comparing the test results given in Table IV. with those recorded above in Table III. As in the case of the previous machine, the tests were carried out by Mr. C. H. Merz, the utmost care being again taken to ensure accuracy. The most economical load was at 5164 kW, when the steam consumption was found to be less than 13·2 lb. per kWh. This result seemed so extraordinarily good that it was decided to verify it by a further test at the same load. This second test, recorded as No. 8 in Table IV., was carried out a week later, the same instruments being used. It was continued for three consecutive hours and, allowing for the less favourable conditions of superheat and vacuum, it corroborated the accuracy of the previous figures.

Two further units, each rated at 4000 kW, were supplied to Carville in 1907, the total equipment of the station thus comprising ten main generating sets of an aggregate rated capacity of 32,000 kW. Quite apart from the greater efficiency of the turbine machinery, the saving it permitted in the size of the engine-rooms, both as regards floor space and height, may be gathered from Fig. 48, which shows the relative dimensions of a 3500-kW reciprocating set and a turbo-generator of the same capacity. The reciprocating engine was indeed definitely obsolete by this time, so far as large central stations were concerned, no important station in Great Britain having installed machinery of the reciprocating type since that at Greenwich, London County Council, was equipped with 5000-kW reciprocating sets in 1904, and even then the decision was considered highly questionable.

(To be continued.)

Senefelder and Lithography.

OF the history of all the branches of the art and mystery of printing, least attention has been paid to that of lithographic or surface printing, an entirely new field which was opened out in 1797 by Aloys Senefelder, of Munich, and the possibilities of which in the intervening years have not yet been fully exhausted. Nor has the inventor himself received all the credit he deserves. However, as the centenary of his death occurs this year, a word or two may be permitted to keep him and his invention in remembrance.

The idea of drawing on a highly polished surface with greasy material that will take printing ink while the untouched surface when wetted will resist it, flashed upon Senefelder almost by accident after he had been engaged for many years experimenting on methods for reproducing, cheaply, music and writing. It was indeed fortunate that he was using at this time a very fine-grained local limestone found at Solenhofen, in Bavaria; no more suitable lithographic stone has been discovered subsequently. The story is told in Senefelder's own words in his "Vollständiges Lehrbuch der Steindruckerey," München, 1817,* and the story repays study with advantage as illustrating the birth and growth of an invention. The work comprises likewise a complete textbook of the art, illustrated by twenty different examples of possible applications, and it is a remarkable fact that the inventor not only brought the art to perfection, but also invented suitable mechanical means for taking off impressions. Furthermore, Senefelder invented the tracing or transfer method, which allows the original drawing to be reversed on the stone, so causing the resultant print to be of the same "hand" as the original. He also invented graining the stone and drawing on it direct with greasy crayons, a method known as chalk drawing. Not only so, but he anticipated such developments as chromolithography or colour printing with colours successively in register, and zincography, which has an advantage over stone for large surfaces.

We find these methods described in the specification of the remarkable patent (No. 2518) taken out in this country in 1801, June 20th, for "Printing on paper, linen, cotton, woollen and other articles." In it also his printing press is figured; this was on the lines of the hand press of the period, but with a roller or squeegee action to obtain the necessary local intensity of impression.

The art spread rapidly, both on the Continent and in this country, largely by the efforts of Senefelder himself. Ackermann and Hullmandel, in England, were early in the field. The art came on the scene at a time when there was a great call for the multiplication of drawings, &c., and met a great want; its very simplicity and cheapness, however, caused it to be commercialised, and indeed vulgarised, so that the word lithograph often connotes something cheap and nasty. On the other hand, in France particularly, its outstanding merit as a means of artistic expression possessed by no other method of reproduction was recognised. As Mr. Pennell says, "A lithograph is

* First English translation 1818; recent translation 1911, J. W. Miller—"The Invention of Lithography."

the drawing itself unchanged, actually as the artist made it, multiplied." The Senefelder Club exists to promote this side of lithography.

It is obvious that the methods described by Senefelder are capable of a number of variations, good and bad, which have been explored. Possibly the greatest single impetus was given by photography, which was pressed into service in the 'seventies. Photozincography is well exemplified in the maps of the Ordnance Survey. Developments were made in the cylinder printing machine to accommodate these new methods.

It is perhaps not too much to say that the recent progress in offset printing owes a great debt to the underlying principle of Senefelder's invention.

Johann Nepomuk Franz Aloys Senefelder, for that was his full name, although he usually made use of the last Christian name only, as a man, is described as quick-tempered, garrulous, wayward and unreliable but not without shrewdness; in spite of the latter quality, he reaped little direct advantage from his invention, but in 1809 he was given an official post in the Royal Bavarian Printing Office. He died a comparatively poor man on February 26th, 1834, and is buried in the Southern Cemetery at Munich. We cannot do better than quote the concluding paragraph of his autobiography (translation): "I desire that soon it (*i.e.*, the art of lithography) shall be spread over the whole world, bringing much good to mankind through many excellent productions and that it may work towards man's greater culture, but that it may never be used for ill purposes. May the Almighty grant this! Then may be blessed the hour in which I invented it."

The Air Ministry Seaplane Testing Tank.

By R. C. MORTIMER, B.Sc., A.M.I.E.E.

WATERCRAFT testing tanks for the purpose of obtaining design data on models of vessels prior to construction are universally employed, and their application to the testing of seaplane hulls and floats is a logical development. A testing tank specially for the study of aircraft problems has been built at the Royal Aircraft Establishment, Farnborough, by the Air Ministry, the acceptance trials being held towards the end of 1932. The mechanical and electrical equipment is of particular interest, there being many novel features in both design and performance.

A general view of the tank building is given in Fig. 4, page 174, which shows the starting end of the tank with its sluice gate, and dock for the flotation of models. The tank length is approximately 650ft., the width 10ft., and the depth 4ft. 6in., the tank walls of reinforced concrete construction being built up above floor level. On the tops of the walls wooden sleepers are laid, carrying running rails for a model-towing carriage spanning the tank, this carriage being fitted with the necessary instruments and carrying observers for the study of the behaviour of the model under test. Power for the electrical propulsion of the carriage is picked up by a collector from a system of wires on the left-hand wall of the building, fed from the shore control cubicle seen in the foreground of Fig. 4. This cubicle in turn is supplied from motor generator sets in a separate machinery room in an adjacent building, illustrated in Fig. 5.

The rails in the tank building are laid to the curvature of the earth's surface, and the distance from the rail head to the water does not vary from a given dimension by more than 0·02in., whilst the difference of level over any yard does not exceed 0·01in. One rail is adjustable for straightness and does not deviate from a dead straight line over the whole length of the track by more than 0·125in. This rail is used for guiding the carriage by means of rollers, fore and aft, as shown in Fig. 6, page 174. Joints in the rails are welded, with the exception of two expansion joints in each rail which are common to both tank and rail system. In order that the level of the rails may be adjusted readily to the limits stated above, the rails are carried on a system of horizontal and vertical wedges. The wedges for horizontal adjustment are carried on the teak sleepers supporting the rails, and the vertical adjustment is obtained by wedges under the sleepers, the wedges resting on cast iron stools fixed in the concrete walls of the tank. To assist in the prevention of expansion troubles the temperature of the air in the building is maintained approximately constant all the year round.

The available power supply is 500 volts direct current, taken into the machinery room to a three-panel main switchboard and feeding the motors of the two motor-generator sets *vid* separately mounted starters. The main motor-generator set comprises a motor, Ward Leonard generator, and series-booster, whilst the auxiliary motor-generator set is made up of a motor, lighting generator, and exciter generator. Of these machines, only the two motors and the lighting generator are controlled from the main switchboard, the remainder being under the control of the shore control panel in the tank building, to which all necessary cables are run by way of a filled-in trench. The shore control panel, Fig. 1, occupies a position convenient to the dock end of the tank, from which all tests commence. Looking from this end down the tank, the collector wires on the left-hand side are arranged in a vertical plane, short connections being made from the shore control panel to the nearer ends of the wires, except in special circumstances, as, for instance, connections to section insulators. There are eight collector wires, strained between stanchions, situated inside the tank building at the extremities of the tank, and stayed to positions outside the ends of the building. Six of these wires are of the loose, round-wire type, with solid carriage collectors, whilst the remaining two, fitted with section insulators, are of grooved section, flexibly suspended, and operate in conjunction with spring-loaded collector shoes on the carriage. Two collector wires are provided for the carriage motor armature supply, one for lighting, one for the carriage motor field circuit, and four for push-button circuits operating in conjunction with contactors mounted in the shore control cubicle. The lowest collector wire forms a common return to all the supply circuits.

The duralumin towing carriage was manufactured by Vickers-Armstrongs, Ltd., Newcastle-upon-Tyne, who were the main contractors for the mechanical and electrical equipment. It is a trussed structure designed to carry, in addition to its own weight and driving mechanism, a dead load of 1200 lb., including observers and the necessary instruments. It is triangulated for vertical loads and for the horizontal forces due to the acceleration and braking loads, and is fitted with four 35 H.P. motors, one at each corner, running at 2000 r.p.m. with short rating.

The Towing Carriage.

The motors, of Metropolitan-Vickers manufacture, are placed one at each corner, and afford individual drives, through machine-cut totally enclosed gearing, to the highly finished track wheels, which are supported on shafts running in ball and roller bearings. The wheels at each end are connected by tubular cross axles, which link the wheels in pairs to prevent racking of the carriage framework. To accommodate the Marryat and Scott solenoid brakes, the motors are furnished with double shaft extensions, the commutator shaft end carrying the brake drums. These details can be seen in Figs. 6 and 7, which show views of the carriage with a seaplane float model in position for testing. A gangway runs down both sides of the carriage framework, which is about 17ft. long, the wheel centres being 13ft., and in the centre of the structure there is a well space 10ft. by 4ft. to accommodate in an unrestricted manner all the instruments required, and affording, at the same time, full facilities for observation.

Since the power of the carriage motors is fixed purely by the carriage acceleration, it was important to keep the carriage weight to a minimum, and this condition was met by adopting an automatic control scheme which requires only minor control apparatus to be accommodated on the carriage. The actual

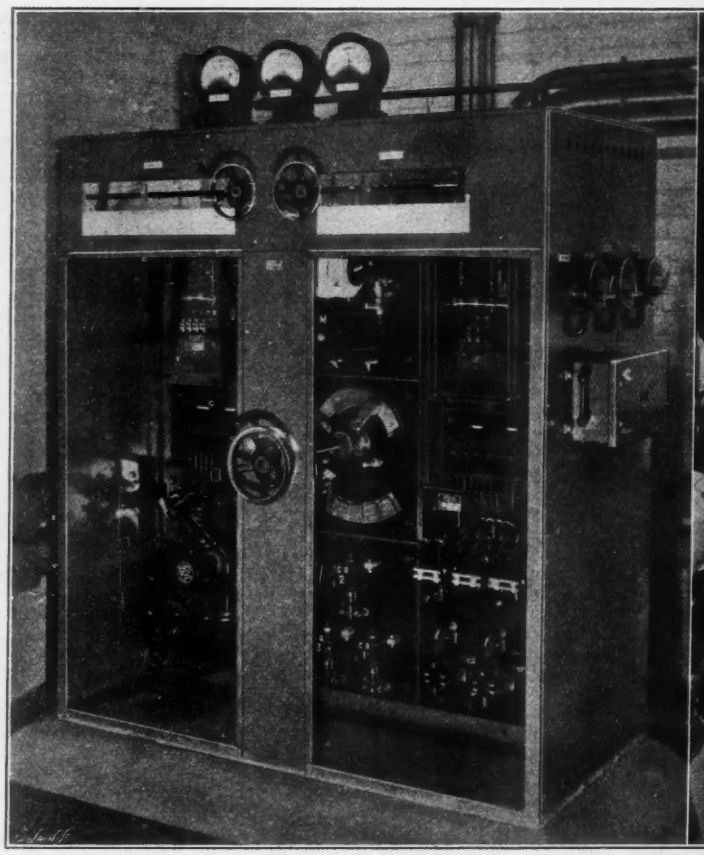


FIG. 1—SHORE CONTROL CUBICLE

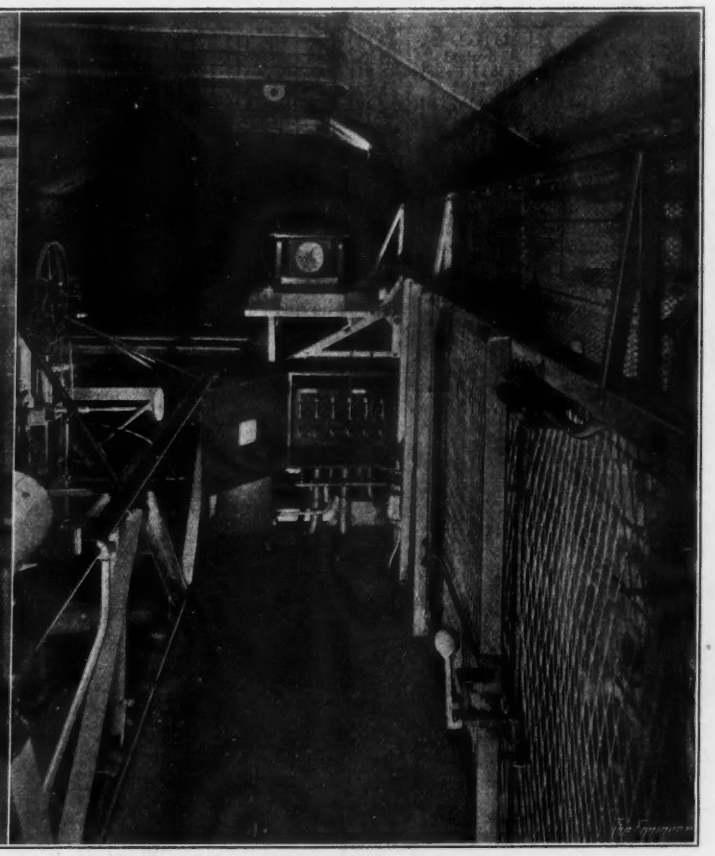


FIG. 2—CONTROL APPARATUS ON CARRIAGE

gear is visible in Fig. 2, which is a view taken from the driver's position looking backwards. The push-button station, fitted with "Forward," "Stop," and "Return" push buttons, is situated on the side of the carriage, whilst immediately underneath is the handle of a remote mechanically operated circuit breaker, which, although not essential for control purposes, is incorporated for emergency protection. The opening of this circuit breaker makes all circuits dead and applies the carriage brakes. At the back, next to the circuit breaker, are two interlocked knife-type selector switches, by which the carriage motor armatures can be connected in "series," "series-parallel," or "parallel" before a test run is made. This completes the carriage control apparatus, except for a field discharge rectifier unit, and additional "Stop" buttons for the use of observers if required.

Speed Control of Carriage.

Before entering into details of the tank operation it is advisable to state the requirements to be met. These briefly are :—(1) The ability to run at carriage speeds from 4ft. to 40ft. per second without a variation of more than ±1 per cent., in steps not exceeding 2ft. per second ; (2) complete acceleration to constant speed to be secured in a distance not exceeding 180ft. starting from rest ; (3) a constant speed run of 200ft.; (4) deceleration to rest in a distance not exceeding 218ft., measured from the end of the constant speed run ; (5) carriage to be capable of being returned to the starting point at a slow speed ; (6) the ability to cause the carriage to creep in either direction for tank cleaning purposes ; (7) the inclusion of automatic deceleration means for both "forward" and "return" directions of travel of the carriage ; (8) the reduction of weight on the carriage to a minimum by the adoption of an automatic control scheme.

The majority of existing water craft testing tanks make use of a large storage battery to secure constant voltage, and hence constancy of speed. This battery necessitates a heavy initial expenditure with considerable maintenance costs, and it was felt that equally good results with a much reduced capital expenditure could be achieved by the use of a combination of machinery and control gear. Accordingly a scheme was developed and the results have fully borne out expectations. The four carriage motors can be connected in "parallel," "series-parallel," and "series" to give a speed range of 4 : 2 : 1, the remaining 2½ : 1 speed range being obtained by variable voltage control. The speed ranges theoretically possible are therefore :—"Parallel" connections, 40ft. per second to 16ft. per second ; "series-parallel" connections, 20ft. per second to 8ft. per second ; "series" connections, 10ft. per second to 4ft. per second. To secure accuracy of constant speed the separately excited carriage motor fields are connected in series and the field current maintained constant by means of a current regulator. The carriage motor armature voltage is also maintained constant at any desired figure in the voltage range by means of a voltage regulator. Voltage control is effected at the collectors on the carriage, thus eliminating voltage drop errors during the run. The final result is an accuracy of constant speed considerably better than that specified.

The peak output of the carriage motor is ample to give the high acceleration, which is effected on the Ward Leonard system by field control of the supply generator, the armature circuit being connected to the carriage motor armatures. Acceleration is rendered automatic by adopting a motor-operated rheostat. Since excessive acceleration current might cause wheel slip on the carriage three current limiting relays are introduced, together with a selector switch, the different relays being put into circuit according to whether the carriage motor armatures are connected in "series," "series-parallel," or "parallel." These relays function by holding up the progress of the motor-operated rheostat until the current has fallen to a safe value. To eliminate loss of time in changing from acceleration to constant speed the field of the supply generator is forced during acceleration by the action of the voltage regulator and the voltage reduced when this instrument takes charge for constant speed maintenance. The accelerating current is killed by a controlled regenerative effect, which is illustrated in Fig. 3. The carriage motor armature voltage chart, which is practically a diagram of carriage speed, shows the quick settlement from a rising to a steady voltage in the angle A B C, which could be varied from a smooth curve to a peaked angle above the constant voltage line by suitably altering the damping of the voltage regulator. The current chart shows the corresponding effect in the quick fall of the accelerating current to the steady running current, the angle D E F being capable of variation from a smooth curve to a sharply re-entrant angle below the steady running current level.

The voltage regulator is made to function at any desired voltage—and hence carriage speed—by variation of the resistance in the control coil circuit. To reduce the work on the regulator contacts an auxiliary hand-operated generator field rheostat is introduced, by which the required voltage is obtained approximately ; the voltage regulator then has only to deal with a small voltage range to secure constancy of voltage. The two rheostats are of the wire-wound barrel type with sliding contacts, and hence there are no clearly defined steps in the possible speed calibrations.

Automatic deceleration in either direction is effected in a novel manner, there being no carriage-operated track switches, as is the usual practice. Two of the collector wires serve to retain the master contactors in the shore control cubicle, one for "Forward" and the other for "Return" carriage travel. Section insulators are introduced into these wires at suitable positions to ensure safe carriage deceleration.

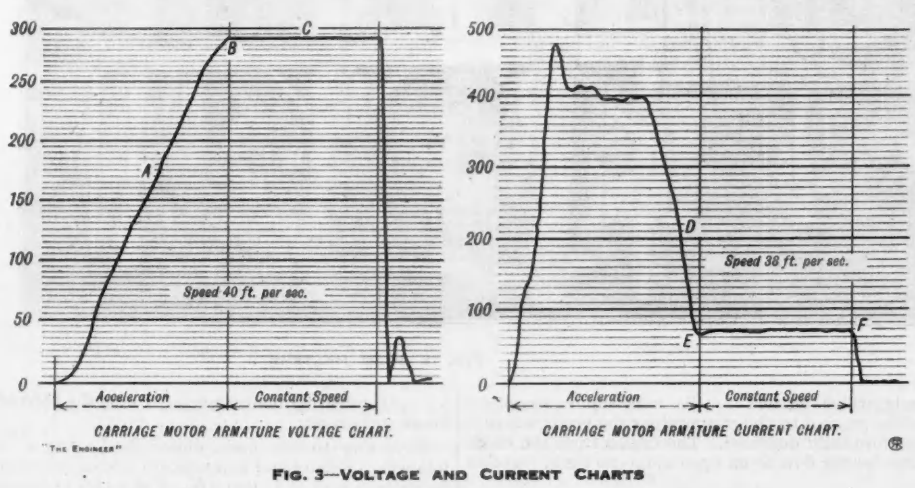


FIG. 3—VOLTAGE AND CURRENT CHARTS

Dropping out the master contactors cuts off all power from the carriage motors and applies the brakes. The return of the carriage to the starting point is easily effected at any desired low speed by making the Ward Leonard generator field through a fixed resistance and reversing the armature connections to give reversed polarity to the carriage motor armatures. The resistance in the Ward Leonard generator field circuit has been made variable in steps, giving a range of return speeds. Creep speeds in either direction are obtained by introducing a large fixed resistance into the Ward Leonard generator field circuit. Only a low voltage is then generated and the carriage speed is proportionately low.

Tank Tests.

To carry out tests the following procedure is adopted. The switchboard in the machinery house is first made live and the two motor generator sets put in motion, the outgoing leads to the control panel in the tank building then being switched into circuit. The live state of the shore control panel and collector wires is indicated by warning lamps fed from the lighting generator. The tremblers of the voltage and current regulators are set in motion by closing the master control switch on the side of the cubicle, which also makes ready for operation all contactor coil circuits. The two speed-control rheostats are then adjusted to give the desired speed, the scales being already calibrated in carriage speeds in feet per second. The final shore operation is to put into circuit the correct acceleration limiting relay according to whether the carriage motors are to be connected in "series," "series-parallel," or "parallel." The driver on the carriage closes the selector switches to connect the carriage motor armatures in either "series," "series-parallel," or "parallel," according to the testing speed desired, closes the circuit breaker and presses the "Forward" button. The whole of the "forward" run then takes place automatically. The "return" journey is similarly accomplished by pressing the "Return" button. An emergency stop can be made at any part of the run by pressing the "Stop" button or operating the circuit breaker on the carriage, or by opening the master control switch on the shore control cubicle. The carriage can be inched in either direction by suitable operation of the starting and stopping push buttons, but for the forward direction of travel the automatic acceleration feature can be rendered inoperative by a hand-operated switch on the shore control cubicle to facilitate inching or creeping.

Progress of the carriage in the same direction after automatic deceleration has been brought about by the action of the section insulators in the collector wires is sometimes necessary, and is possible by holding the correct starting button continuously depressed whilst movement is desired. To prevent dangerous operation of this feature in the "forward" direction of travel, namely, by driving under full power into the emergency brake at the end of the run, the push button is inoperative in the dead section except when the automatic acceleration of the carriage is cut out of action. If this is done the speed of the carriage is restricted to a low figure, since no resistance in the Ward Leonard generator field is cut out by the motor-operated rheostat. It should be mentioned that a mechanical emergency brake is provided at the finishing end of the tank for emergency stopping, the brake comprising spring-loaded metal shoes carried on the carriage and arranged to grip a stationary plate mounted on the tank sides. One spring-loaded shoe can be seen in the right-hand foreground of Figs. 6 and 7.

Actual Results.

In the official trials no difficulty was experienced in meeting all requirements for the carriage propulsion. The full range of carriage speeds could be obtained although the actual overlaps in the possible speed ranges are less than the theoretical figures, but this cannot be considered as a shortcoming. Selected speeds could be held constant without difficulty. The acceleration rate is considerably higher than that in use in any other tank where the drive is taken through the running wheels. It should be remembered that sanding is not allowable, whilst the rails are polished and kept free from dust or moisture. In addition, whilst the accelerating distance allowed is 180ft., this length has to include a reasonably non-jerky start and also the settling period from acceleration to constant speed. These items have been kept to a minimum, but nevertheless the acceleration rate is very close to the theoretical limit, although wheel slip was not experienced during acceleration. The braking rate is also high, but by careful balancing of the load over the four brakes consistent results could be obtained without slipping of the wheels. Braking was very smooth at high and medium speeds, but at very low speeds the retardation was inclined to be somewhat abrupt. The emergency brake was also tested up to speeds in excess of half the maximum, which was sufficient to indicate that the carriage could be pulled up in the length of the brake from maximum speed.

Creep speeds as low as 0·5ft. per second were possible but are not to be recommended in view of the possibility of burning out the short-rated field systems of the motors, and a minimum of 1ft. per second provides all that is required. Despite the very high peak rating of the carriage motors, the commutation was sparkless at all speeds. No difficulty was experienced with sparking at the collector wires, although at acceleration to maximum speed the current is as high as 450 ampères on the main wires. The application of the loose wire system for such high currents and speeds was somewhat experimental, but it has given excellent results.

Brecknell, Willis and Co., Ltd., were sub-contractors to Metropolitan-Vickers Electrical Company for the collector gear portion of the contract, whilst the power wiring was carried out by W. J. Furse and Co., Ltd., Manchester, also as sub-contractors. As previously stated, Vickers-Armstrongs, Ltd., were the main contractors for the supply and fixing of the rails, carriage, emergency brake and propulsion equipment, whilst the whole of the electrical equipment was provided and installed by the Metropolitan-Vickers Electrical Company, Ltd., acting as sub-contractors to Vickers-Armstrongs, Ltd.

THE MOTOR YACHT FRIXOS.

A NEW motor yacht, the "Frixos," designed and constructed by John I. Thornycroft and Co., Ltd., of London and Southampton, for a foreign owner, underwent successful trials on the Thames at Long Reach on Tuesday, Feb. 6th. Although the vessel is not large and only has a measurement of 38 tons and a length of 55ft., with a beam of 13ft., she is sturdily built for keeping at sea over long periods under adverse weather conditions. Her hull is built of teak, and is double skinned, with a copper-sheathed bottom. The propelling machinery comprises a twin-screw arrangement of Gardner six-cylinder oil engines, each of which has a designed output of 57 S.H.P. at 1000 r.p.m. The engines are controlled directly from the navigating bridge. On the trials the designed speed of 9¼ knots was easily attained, and the yacht was shown to be remarkably handy and easy to manœuvre. The "Frixos" is one of several yachts which John I. Thornycroft and Co., Ltd., are building for foreign owners, which points to the preference abroad for motor craft of British design and construction.

The New Barking Power Station.

No. III.

(*Concluded from page* 147, *February 9th.*)

THE Hick, Hargreaves condensers each condense normally 407,000 lb. of steam when maintaining a vacuum of 29in. at the condenser exhaust inlet when supplied with circulating water at 60 deg. Fah. The total cooling surface in the two riveted mild steel shells (Fig. 17), made in two sections, is 68,000 square feet. One half of each condenser can be cleaned, while the other is in service. Each shell has two passes on the water side and the tubes are arranged to give a regenerative effect in accordance with the maker's latest practice. Both condensing equipments have a 100 per cent. duty "Hivac," three-stage air ejector (Fig. 19), comprising three steam-operated jets, working in series, with intermediate and after surface coolers utilising the condensate from the condenser as the cooling medium. While these ejectors are in an accessible position on the turbine floor level, all water connections are below that level. As a standby, each condensing plant has a 100 per cent. duty "Hivac" two-stage ejector with a surface auxiliary condenser and after cooler. The cooling medium in this case is taken from a tapping off the main condenser circulating water system. Duplicate "Hivac" extraction split casing pumps, as in Fig. 20, also supplied by Hick, Hargreaves, discharge directly through the ejector condensers into the feed heaters, associated with the closed feed system.

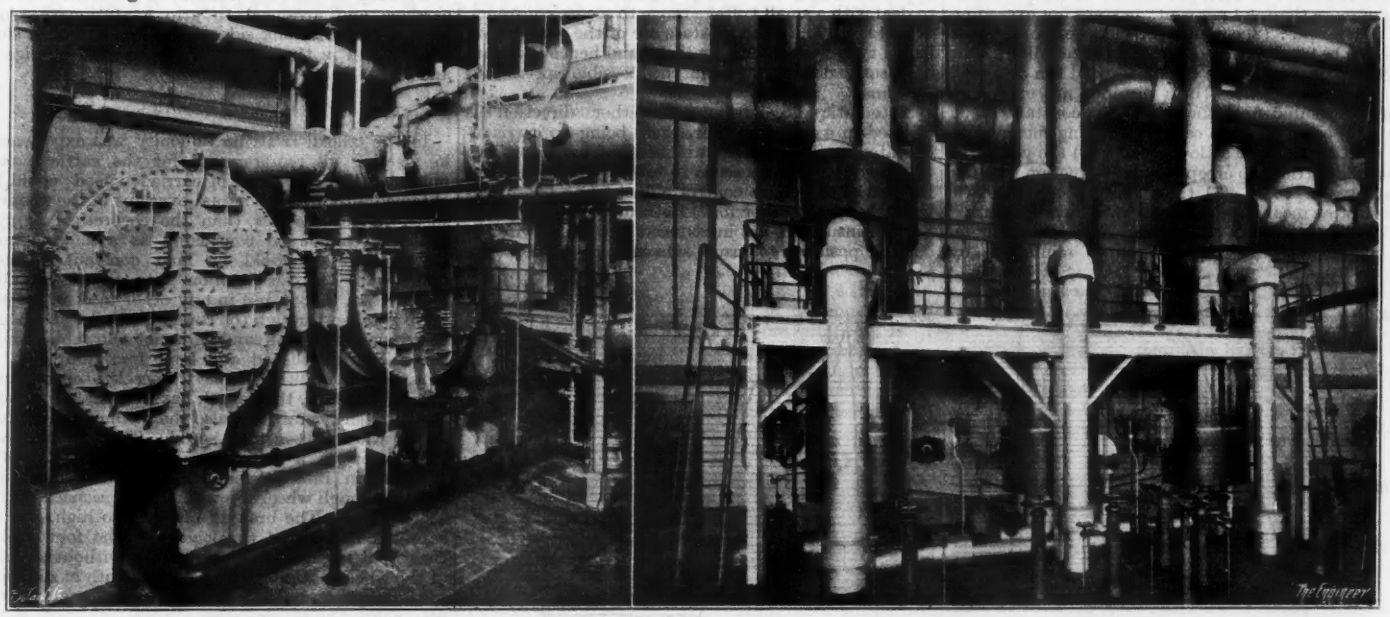


FIG. 17—TWIN CONDENSER

FIG. 18—FEED HEATERS

CLOSED FEED SYSTEM.

It will be perceived from Fig. 21 that regenerative feed heating is obtained by four-point bleeding on the main turbines. There are also ejector, gland and drain flash heaters in the actual feed-heating circuit. The gland, L.P., and flash heaters are on the feed circuit between the extraction pump and boiler feed pumps, but the intermediate, evaporator and H.P. heaters are between the boiler feed pump and boilers, and are consequently designed for a maximum pressure of 1000 lb. per square inch, and a test pressure of 1700 lb. The three H.P. feed heaters, using bled steam from the H.P. and I.P. bled steam lines and the steam produced by the evaporators, are shown in Fig. 18. The H.P. and I.P. heaters are "U" tube heaters, with the tubes expanded into a tube plate which is an integral part of the water-box.

The automatic by-pass valve—Fig. 22—is under the control of a float-operated relay on each of the three H.P. heaters, so that in the event of leakage occurring from the H.P. system into the heater steam space, and causing flooding on the steam side, the flow of feed through the heaters is instantly diverted and the water flows directly to the boilers. Drains from the H.P. heater system run to a flash heater, and as they pass through the steam trap a reduction of pressure occurs and the steam that is flashed off owing to re-evaporation is condensed, the cooled discharge then passing to the L.P. heater. Drains from the latter heater are fed forward by an independent drain pump into the feed suction main, but in the event of this pump being put out of action they can be trapped back to the main condenser. Under normal conditions, however, the forward feeding in the manner described avoids any loss of sensible heat.

The make-up water is supplied by two unit evaporators taking steam from the H.P. tapping on the turbine and passing the vapour to the second H.P. heater. Special precautions are taken to avoid any entrainment of gases in the system as the result of the introduction of raw water. One of the evaporators associated with each generating set was made by G. and J. Weir, Ltd., and the other by Hick, Hargreaves, Ltd. The drains from the evaporator heaters are utilised to preheat the crude water which is then passed to a patented Hick, Hargreaves spray type de-aerator, and then through a second series of crude water heaters to the make-up evaporators. Before passing to the evaporators the crude water is therefore fully degassed. The drains from the crude water heater flow to an open make-up tank, together with various other drains from the system, and are admitted to the main condensate system by a ball float valve. Before entering the main system, however, they are subjected to further degasification in small spray degasifiers operating at condenser vacuum. Under full-load conditions the evaporators can supply 26,000 lb. of make-up water per hour.

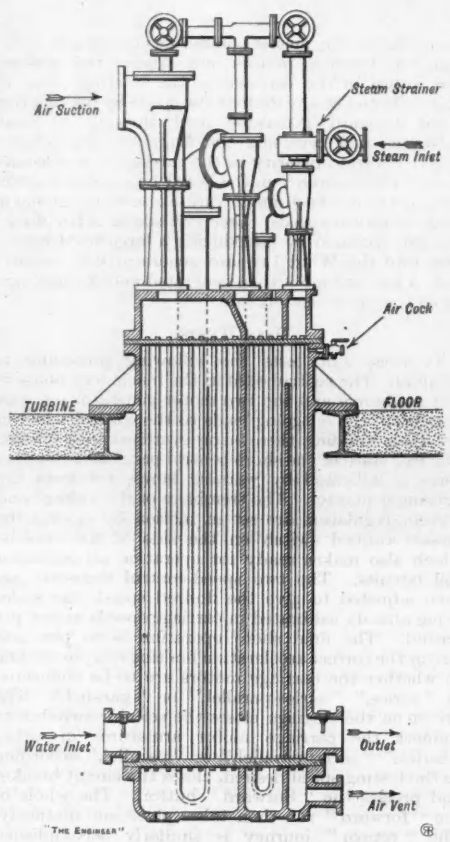


FIG. 19—THREE-STAGE AIR EJECTOR

CENTRAL EVAPORATING PLANT.

Besides the evaporators mentioned, Hick, Hargreaves supplied a central three effect evaporating plant capable of giving a total output of 50,000 lb. of pure distilled water per hour at 100 deg. Fah, when supplied with 16,500 lb. of steam per hour at a pressure of 600 lb. gauge and 800 deg. Fah. There is a raw water heater between each stage, and a vapour condenser capable of dealing with 15,150 lb. of vapour per hour. The vacuum in the condenser is maintained at 26in., with a "Hivac" two-stage surface-cooled ejector. A de-superheater associated with the plant reduces the temperature of the steam from 800–850 deg. Fah. down to saturated temperature. All sludge pumps, &c., for this plant were also supplied by Hick, Hargreaves, who were also responsible for the condensing plant associated with the 3500-kW house service set.

Reverting to the main closed feed system, the following pressure and temperature figures quoted are based on a load of 75,000 kW. The water extraction pumps draw the condensate from the condensers at a temperature of 80 deg. Fah. and normally pass it through the three-stage air ejector heater, where the steam used for extracting the air from the condensers is used for heating the water up to a temperature of 83 deg. Fah. After leaving the air ejector the condensate passes through the gland heater, in which its temperature is raised by leakage steam from the turbine glands to a temperature of 86 deg. Fah. Next comes the L.P. heater taking bled steam at a pressure of 18 lb. per square inch absolute, in which the water is heated up to 212 deg. Fah. After the L.P. heater the water passes through the flash heater, which takes the drain water from the high-pressure heaters. From the flash heater, which heats the condensate up to a temperature of 217·5 deg. Fah., the water passes to the feed pump suction main which is a common header to which the suctions of all the feed pumps are connected. This temperature of 217·5 deg. Fah. is raised to 220 deg. Fah. by the water discharged from the drain pump. There are four Mather and Platt motor-driven feed pumps and three Weir steam turbine-driven feed pumps, and each pump is capable of delivering 410,000 lb. of water per hour against a pressure of 850 lb. per square inch (gauge).

The pumps discharge into a common header, from which the water passes through the I.P. heater, where steam bled from the turbine cylinder at a pressure of 59·9 lb. per square inch absolute heats the feed water up to a temperature of 273 deg. Fah. The water inlet to this heater is under the control of a motor-operated valve which is provided with inching gear and with push-button control on the B.T.H. turbine gauge board. Next comes the evaporator heater, which is normally supplied with the vapour from the unit evaporators at a pressure of 109 lb. per square inch absolute, which heats the feed water up to a temperature of 304·5 deg. Fah. The final increment of temperature is added to the feed water as it passes through the H.P. heater, which takes bled steam from the turbine at a pressure of 182 lb. per square inch absolute, to heat the feed water up to a final temperature of 352 deg. Fah., after which it passes to the boilers.

Variations of boiler feed water required by the feed pumps during normal working are taken up by balance pipes extending from the condensate pipe between the gland heater and L.P. heater to the hot

wells, so that if the feed pumps require more water than the extraction pumps are supplying at the moment the water is drawn from the hotwells or, inversely, if the feed pumps require less water the water returns to the hotwells. The pipe work is arranged so that the hotwells can be connected direct to the feed pump suction header. An automatic by-pass valve provided on the condensate line across the gland heater, operates with a rise in pressure at the heater inlet due to increased friction drop over the heater at high loads. A by-pass to atmosphere is also provided on the steam side of the heater.

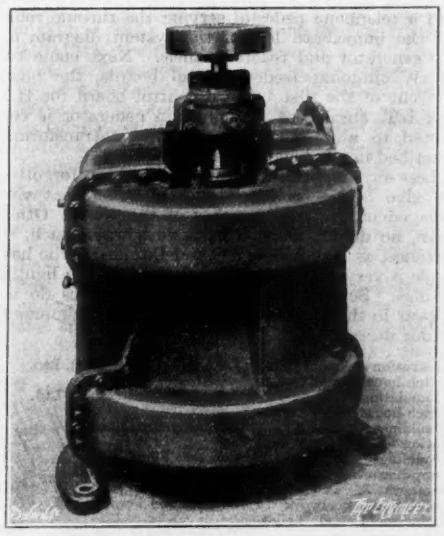


FIG. 20—EXTRACTION PUMP

A hand by-pass from the outlet of the gland heater to the feed pump suction main, enables the L.P. heater and flash heater to be cut out of service. There is also a hand by-pass for cutting out the I.P., evaporator and H.P. heaters.

For starting up purposes a water supply from the hotwells is provided for the condensers. With this water flowing to the condensers the extraction pumps can be started up and water pumped through the three-stage air ejector to the hotwells *viâ* the balance main. Vacuum can thus be obtained by means of the three-stage ejector before the normal condensate is available from the condensers. The normal make-up water supply to the evaporators consists of town water, which is first softened to about 4 deg. of hardness in the softening plant described last week.

Two hotwells are installed on the roof of the turbine-house and are normally interconnected. Isolating valves enable one hotwell to be taken out of service if desired or isolated from the other during tests. Three reserve feed-water tanks, situated at ground level outside the boiler-house, are supplied with distilled water from the evaporators. In the case of the unit evaporators, the distilled water enters the feed system, and should water be required in the reserve tanks from these, the hotwells are allowed to fill up and overflow to the reserve tanks through connections provided for this purpose. In the case of the central evaporating plant the distilled water is taken direct to the reserve tanks.

In the event of the level of water in the hotwells falling below a predetermined figure, reserve pumps pump distilled make-up water to the hotwells from the reserve feed-water tanks. The supply of this water into the hotwells is controlled by ball float valves, so that when the water level rises to its correct height in the hotwells, the valves close and prevent a continuous circuit from the reserve feed-water tanks back again through the overflows from the hotwells to the reserve tanks. Make-up water may in emergency also be supplied by gravity from tanks situated on the boiler-house roof, these tanks being supplied with softened town water by means of electrically driven pumps. This water is controlled by ball float valves arranged to come into operation at a very low level in the hotwells, so that the water will only be used in extreme emergency.

CIRCULATING WATER SYSTEM.

The contract for the complete circulating water system, comprising four 52in. circulating water pumps, two 8in. silt pumps, and two 3in. bilge pumps, was awarded to W. H. Allen, Sons and Co., of Bedford. The main pumps, which are of the "Conqueror" vertical double-suction centrifugal type, are mounted in pits and the motors, Fig. 23, are 43ft. above them. The transmission shaft is enclosed in a steel casing. At the floor level there is a cast iron bedplate for each motor with a self-lubricating Michell thrust bearing combined with a self-lubricating journal bearing. Each of the four circulating pumps will deliver 47,000 gallons per minute against a total head, allowing for pipe friction, and the effects of syphonic action, of 41ft. The speed is 367 r.p.m., and the efficiency 86 per cent., demanding a motor output of 680 horse-power. In determining the size of the motors, however, consideration had to be paid to the fact that provision had to be made for a possible increase in head and quantity of water. The pump casings have been made so that a larger impeller may be added at a later date, and each of the Metropolitan-Vickers three-phase motors is rated at 900 B.H.P., and is wound for 3000 volts. They are started by directly switching them on to the line.

The two 3in. vertical single-suction open impeller bilge pumps serve for draining the sumps at the bottom of the circulating water pump pits. With the exception that, in place of a power-driven grease pump, a hand-operated pump is provided, the general arrangement of the shafting and lubricating system is the same as that of the main pumps. The bilge pump motors also supplied by the Metropolitan-Vickers Electrical Company, are squirrel-cage machines, wound for 400 volts and run at 1455 r.p.m. The two horizontal electrically driven silt pumps are used to prevent the accumulation of silt under the pump house jetty, and each pump is directly coupled to its Metro.-Vick driving motor. Both pumps will deliver 1500 gallons per minute against a total head of 200ft. when running at 1450 r.p.m. and absorbing 130 horse-power. The motors are 400-volt, enclosed ventilated, squirrel-cage machines, and are rated at 150 horse-power. While the starting current of the main circulating pump motors is 1090 ampères, that of the lower voltage silt pump motors is 1195 ampères, and that of the bilge pump motor 82 ampères.

The suctions of the main pumps are connected to the screening chamber by 52in. bell-mouthed connections grouted into the concrete. Each pump suction has a 52in. motor-operated Blakeborough

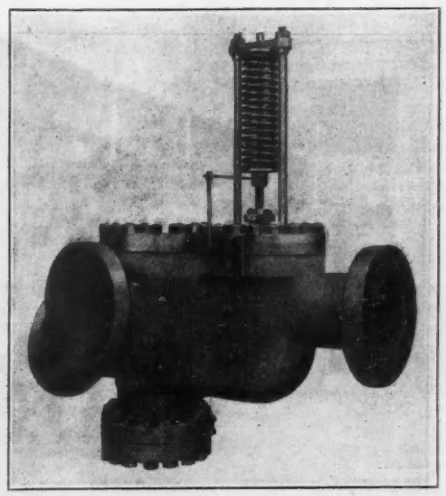


FIG. 22—BY-PASS VALVE

valve, but in the event of the motor failing the valve may be operated by a capstan. From each main pump the discharge rises vertically, and is connected to a 72in. bus main with alternative outlets. Each discharge has a 52in. Blakeborough reflux valve and a 52in. motor-operated sluice valve, which, like the suction valves, can be controlled from the operating floor level. Three 72in. Blakeborough electrically operated valves are fitted in the bus main for sectionalising purposes.

SCREENING EQUIPMENT.

There are five Brackett central flow band screens, each having a maximum capacity of 3,000,000 gallons of Thames river water per hour at the lowest water level, when immersed 12ft. Each screen stands in a sump 43ft. deep, and to allow for a variation in water level of 29ft. has an overall length of about 50ft. It is well known that in screens of this type the normal path of the water is through both sides of the band, which is revolved slowly and carries up the rubbish in the water to the top of the screen, where it is washed off by high-pressure jets into a discharge trough, common in the case under consideration to the five screens, and discharging into

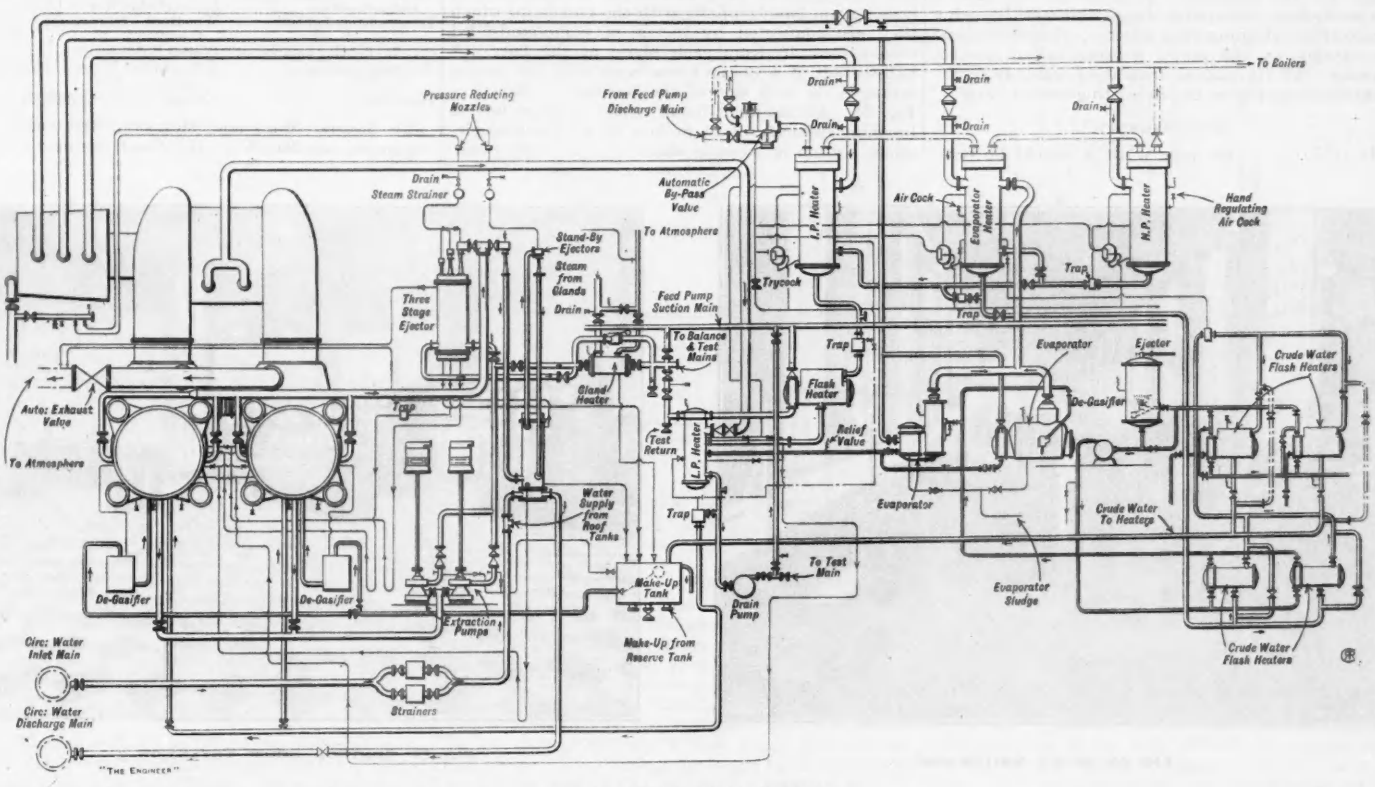


FIG. 21—CLOSED FEED SYSTEM

concrete rubbish tanks at either end of the pump-house. Each screen has a steel gate facing the incoming water below water level, and under emergency conditions it automatically opens and allows the water to be drawn through the centre of the screen frame to the main circulating pumps. The opening mechanism is set in motion by a predetermined difference in hydrostatic pressure between the dirty and clean side of the band, and there is no possibility of a failure in the condensing water supply. Hand operation is also provided for.

Each screen has its own driving gear and cleaning water pump set, mounted on the screen head, consisting of a 6 horse-power motor running at 1460 r.p.m., and flexibly coupled on one side to a double-reduction gear-box driving the screen head through a roller chain, and on the other side to a Brackett 2in. two-stage pump, which supplies the high-pressure water for the cleaning. As a precaution against the jet choking, each pump draws its water through a Brackett self-cleaning twin strainer, while Seabourne intercepters on the pump suctions ensure correct priming. All the pumps draw their water from the main discharge pipe of the circulating water system.

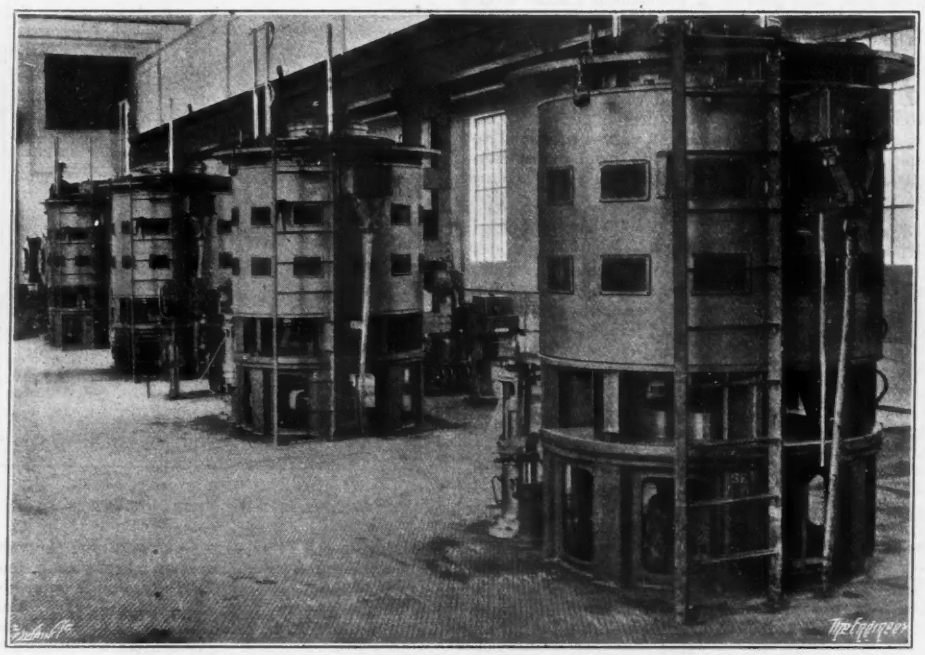


FIG. 23—CIRCULATING WATER PUMP HOUSE

PIPE WORK.

In referring to the pipe work it should be mentioned that a very effective colour scheme has been adopted to enable the different pipes to be distinguished. The order for all the pipe work, including pipes for the circulating water system, condensate system, water-softening plant, compressed air and steam mains, was awarded to Stewarts and Lloyds, Ltd., which sub-let the contract for the latter piping to Aiton and Co., Ltd. Three reserve feed water storage tanks, two hotwells and tanks for the weighing system were also included in the Stewarts and Lloyds' contract. The H.P. valves were supplied by Hopkinsons, Ltd., and the L.P. valves by Blakeborough, Ltd. All bends on the Aiton high-pressure pipe work are creased or corrugated. Corrugated bends were used to give the flexibility necessary to absorb the expansion caused by the high operating steam pressure, while creased bends have been employed both on the steam and feed range in order that the tube may not be thinned in the process of bending. Aiton Corwell joints have been adopted on the steam and feed ranges for the pipes, receivers, and valves. Two Aiton steam receivers have forged bodies and welded-in branches.

SWITCHGEAR.

All the main 33-kV switchgear in the old and new stations was manufactured by A. Reyrolle and Co., Ltd. Each of the switch-house buildings for the A and B stations comprises two wings, and by means of an emergency bus-bar isolating equipment erected in a self-contained chamber dividing the wings, the bus-bars in each can be split into half sections. The bars are enclosed in a metal-clad compound-filled housing run longitudinally with the panels, to which they are connected by means of compound-filled trunks teed off from each phase of the bars. A half-section of a switch-house wing with the panels arranged on each side of the bus-bars is shown in Fig. 24. All the multi-break circuit breakers have a breaking capacity of 1½ million kVA. Each single-phase section is accommodated in a separate cylindrical boiler plate tank, while all three units are mounted on a common top plate. A common vent header, with baffles and non-return valves, conveys the gases to the exterior of the switch-house.

By means of an overhead crane complete breakers can be lifted vertically from the panels and removed to a framework in the hospital bay, and as a breaker is withdrawn doors are automatically closed in the openings in order to prevent access to the live conductors. The system of complete phase separation is also followed on the bus-bar selectors and feeder isolators, which are all enclosed in individual oil-filled tanks. These selection and isolating switches are hand-operated from the switch-house operating gallery. Voltage, instrument, and protective gear transformers are housed in the feeder isolator tanks. To prevent incorrect operation there is a system of mechanical and electrical interlocking.

There are two earthing systems. One is controlled locally from the gallery, while the other automatically earths all conductors when the selector and isolating switch tanks are lowered.

The establishment of the new station has naturally led to extensions to the control room, and Fig. 25 shows the new Reyrolle equipment. On the extreme right there is a system diagram, and immediately in front of it a system telephone desk. In front of this desk are two generator governor control pedestal and a telephone pedestal serving the turbine room. To the immediate left of the system diagram are the generator and reactor panels. Next come two 33 kW outgoing feeder control boards, the board in front of the first being a control board for H.T. and L.T. auxiliaries. Each main generator is connected to a 93,750 kVA Hackbridge transformer, nescribed in our issue of May 12th, 1933.

Lest any important contractor has been forgotten, we give below an official list of firms that were engaged on various branches of the work. Others have, no doubt, assisted in various ways, such, for instance, as Fredk. Thomas and Co., Ltd., who have made a very fine job of the station electric lighting fittings. Several other firms whose names do not appear in the list have been mentioned in the course of our descriptions :

Excavation and sidings ..	John Gill (Contractors), Ltd.
Switch-house and office foundations	John Gill (Contractors), Ltd.
Switch-house and office buildings	Holloway Bros., Ltd.
Station foundations and buildings	Concrete Piling, Ltd.
Pump-house and jetty ..	Peter Lind and Co., Ltd.
Chimneys	Custodis (1922), Ltd.
Switch-house steelwork ..	Sanders and Forster, Ltd.
Engine-room and boiler-house steelwork	Babcock and Wilcox, Ltd.
Turbine plant	British Thomson-Houston Company, Ltd.
Turbine-house cranes ..	Sir William Arrol and Co., Ltd.
Condensing plant	Hick, Hargreaves and Co., Ltd.
Condenser tubes	Hudson and Wright, Ltd.
Circulating water pumps ..	W. H. Allen, Sons, and Co., Ltd.
Circulating water screens ..	F. W. Brackett and Co., Ltd.
C.I. circulating water pipes	Stanton Ironworks Company, Ltd.
Boiler Plant	Babcock and Wilcox, Ltd.
Jetty coal unloading cranes	Sir William Arrol and Co., Ltd.
Coal-handling plant, including travelling bridge and belt conveyors	Fraser and Chalmers Engineering Works
Gravity bucket conveyors	Robert Dempster and Sons, Ltd.
Piping equipment and auxiliary plant	Stewarts and Lloyds, Ltd.
Switchgear and accessories	A. Reyrolle and Co., Ltd.
Transformers	The Hackbridge Electric Construction Company, Ltd.
Main and auxiliary cables and accessories	Enfield Cable Works, Ltd.
Power station lighting ..	Woodford Showrooms (County Company).
CO_2 fire-fighting equipment	Walter Kidde and Co., Ltd.
Auxiliary switchgear ..	Metropolitan-Vickers Electrical Company, Ltd.
Reactors	English Electric Company, Ltd.

To Messrs. Merz and McLellan, the consulting engineers, and Mr. W. J. H. Wood, engineer-in-chief to the County of London Electric Supply Company, we tender our best thanks for assistance in the preparation of these articles.

FIG. 24—33-KV SWITCHGEAR

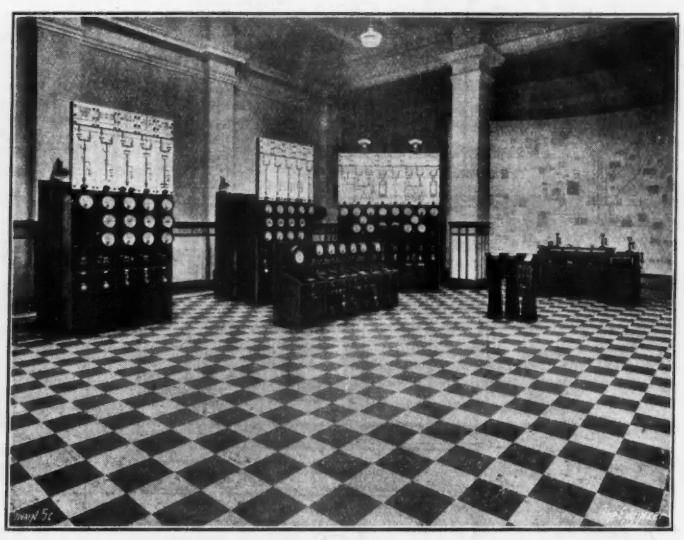


FIG. 25—CONTROL ROOM EXTENSION

REFERRING to a mention in these columns of a recent visit of the Duke of Gloucester to Park Works, and a demonstration of the "Mulsifyre" system of extinguishing oil fires, Mather and Platt, Ltd., ask us to point out to our readers that the fundamental principle of the "Mulsifyre" system is to extinguish inflammable liquid fires by the use of water only, and the "Mulsifyre" must not, therefore, be confused with any form of foam extinguisher.

The Lagny Accident.

AS recorded in our issue of December 29th, 1933, a lamentable French railway accident occurred on Saturday, December 23rd, near Lagny, on the Est line, when the express from Paris to Nancy was telescoped by a train from Paris to Strasburg. Owing to a fog which was dense around Paris and made visibility very bad along the line, the trains started an hour and a half late, but at their regular intervals. The express was composed of nine wooden coaches, and the Strasburg *rapide* was drawn by a "Mountain" type locomotive with steel coaches, the former train carrying a particularly heavy Christmastide load of passengers. Between Lagny and Vaires, about 16 miles from Paris, the express was stopped by signals for quite a long time, and the Strasburg train coming up behind at a speed of about 60 miles an hour, which was below the maximum speed permissible on that section of the line, practically ran through four coaches, smashing them up completely and destroying a fifth coach. Over 200 passengers were killed and about 400 injured.

Without attempting to discuss the circumstances attending the Lagny accident, and defects in the system or negligences which may have contributed to that collision, especially while the matter is *sub judice*, it is, nevertheless, of interest to discuss the problem of the safe operation of trains in a general manner, and particularly the conditions obtaining on the French railways. In what follows we give an abstract of an article dealing with this subject which was contributed by Monsieur Ch. Dantin to our esteemed French contemporary *Le Genie Civil*, and which appeared in the issue of that journal of January 20th.

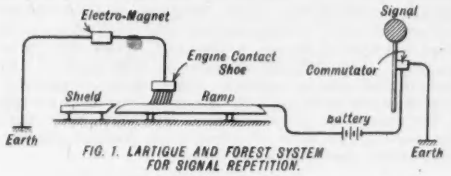


FIG. 1. LARTIGUE AND FOREST SYSTEM FOR SIGNAL REPETITION.

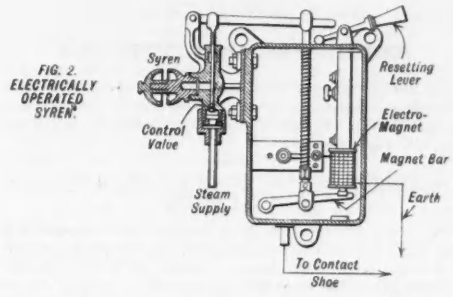


FIG. 2. ELECTRICALLY OPERATED SYREN.

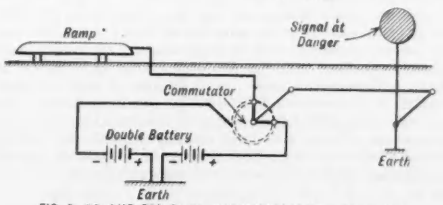


FIG. 3. SCHEME FOR SYREN WITH RECORDING MECHANISM FOR CLEAR AND DANGER SIGNALS.

FIG. 4. FLAMAN SIGNAL RECORDING STRIP

"THE ENGINEER"

FIGS. 1 TO 4—FRENCH CAB-SIGNALLING SYSTEM

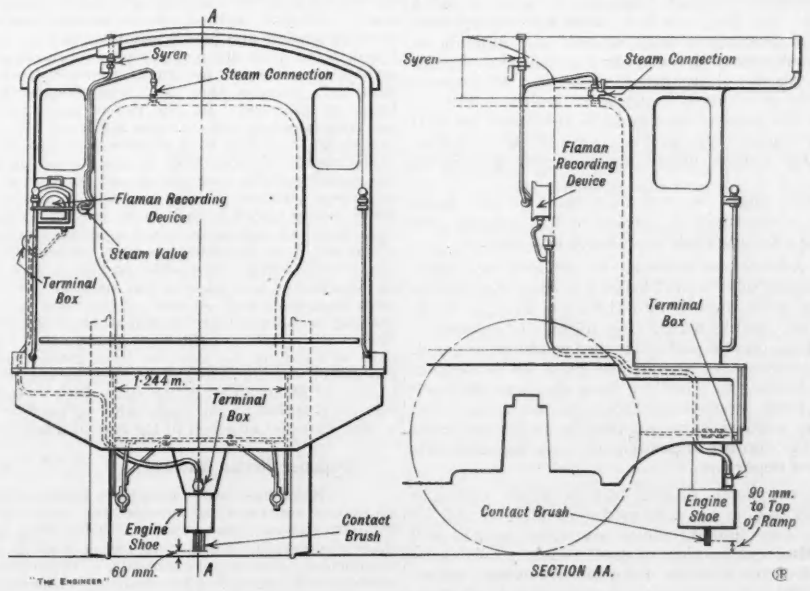
CAB SIGNALS.

As indicated in Figs. 1 and 5, the ramp is placed in the centre of the track, parallel to the line, and forms a fixed contact 2 m. to 4 m. in length. It is composed of a block of wood covered with a brass strip. The entry of the engine shoe is facilitated by a shield placed immediately before the ramp in the direction the engine is travelling. In the simplest form, the brass plate is connected to the positive pole of a battery of cells placed at the side of the line, and the negative pole of the battery is, in turn, connected to a commutator on the signal, so arranged that it is earthed when the signal is at danger.

On the locomotive itself there is a shoe fitted with a wire brush, which, making contact with the ramp, closes the circuit and causes a current to flow in the coils of an electro-magnet housed in a syren control box on the locomotive. A section through this box is shown in Fig. 2. The other end of the magnet winding is earthed. The energising of the magnet bobbins changes the polarity of the core and so lessens the attraction of a permanent magnet on the pivoted lever, thereby allowing the lever, shown in Fig. 2 in its upper position, to fall. This movement opens the steam valve, Fig. 2, and brings the syren into operation. A small handle for resetting the lever is provided. In order to prevent the possible breaking of contact on the surface of the ramp by the formation of a layer of ice, a strip of felt soaked with petroleum is placed between the brass strip and the wooden block which forms the ramp. The petroleum is allowed to leak through holes in the plate, and, spreading over the surface, prevents the formation of frost films.

The movements produced when the shoe passes over the ramp are recorded by a special instrument of the Flaman type, which is installed in the cab. It consists essentially of a pen which is moved by a small electro-magnet in circuit with the main system for operating the syren which we have already described. As well as recording all the signals as they are passed, it is also possible to record a distant signal at danger. This is done by making use of a double battery of cells arranged in the manner shown in Fig. 3. By means of a commutator, the ramp is connected to the positive side of the battery when the signal is at danger, and to the negative side when the signal is at clear, the other poles of the battery being earthed in the manner shown. The recording of signals on this system is effected by the use of two electro-magnets, wound for different polarity, which are mounted in series with the main circuit operating the syren. The paper strip on which the signal positions are recorded appears as in Fig. 4, the upper vertical markings being indications of signals passed in the clear position, and the lower marks those of signals passed in the danger position. There is also usually a provision made whereby the driver of the locomotive can record his signal observations by pressing a lever when he sees the signals, this lever producing a special line on the diagram which precedes the record made as the engine passes over the ramp. This provision for checking the vigilance of the driver is to prevent his dependence on the hearing of the syren and neglect to observe the signals.

The drawing reproduced in Fig. 5 illustrates diagrammatically the arrangement employed on a locomotive on the Est Railway, particulars of which were published in the *Revue Generale des Chemins de Fer*, of March, 1925. It shows clearly the engine shoe, the Flaman recording apparatus, the steam valve, and the syren. These are arranged in such a way as to reduce as far as possible the part played by the electric current, a relay being employed so that the current necessary for operating the recording mechanism and the syren can be supplied by the locomotive. This is done to reduce to a minimum any risk of failure which might be caused by a breakdown in the electric system.



"THE ENGINEER"

FIG. 5—ENGINE EQUIPMENT FOR CAB-SIGNALLING

AUTOMATIC BRAKING.

From cab signalling it is but a small step to making the signals themselves operate automatic brakes on the train, instead of merely bringing to the notice of the driver the urgent necessity for him to apply the brakes. Nevertheless, in spite of tests which were formerly made on the Nord line, and more recently on the Orleans line, the French Railways have hesitated to go forward in this matter. As explained by Monsieur l'Inspecteur General Maison, Professor at the School of Mines in Paris, in a study entitled "Exploitation Technique des Chemins de Fer"*:

> "The bringing to rest of a train is a delicate, technical operation, which demands on the part of the driver a quick appreciation of the situation and a decision to act, combined with considerable care in the braking of the train. It may be feared that the automatic braking apparatus would exercise too sudden or too slow an action, which might lead to harsh braking, or too slow stopping of the train. Again, the men on the footplate, thinking that safety had been increased by automatic brakes, might be tempted to relax their vigilance. It can be definitely stated that automatic braking, while attractive at first sight, presents more difficulties than advantages, and in the view of French railway engineers it seems preferable to leave to the men in the cab the whole responsibility for the driving of the train, but to assist them as far as possible in their observation of the signals by the use of an automatic apparatus which does not lessen security, and, at the same time, does not weaken the vigilance as it is designed with a provision for hand control."

THE LAGNY ACCIDENT.

In the Lagny case, the opinions of the experts have yet to be made known, and it is difficult, says our contemporary, to say exactly just what took place. It appears, however, that the accident was probably caused by one of two happenings: (*a*) a signal defect; and (*b*) failure of the driver to observe signals at danger.

A signal defect, however, may be regarded as unlikely, as an accident resulting from a circumstance of that kind is very rare, and it must be borne in mind, too, that the working of the signals and their controls, both mechanical and electrical, is so contrived that there is very little chance of a failure taking place, and if one should happen, the signal is automatically placed at danger. As to the possibility of a signal having been overlooked, that circumstance may have been caused by the thick fog which, at the time of the accident, rendered observation difficult. But the driver should have heard the alarm syren operated by the ramp of the distant signal; yet, if the accounts given by the various journals are to be taken as true, the alarm syren was not heard. If so, the syren failure may have been caused by the face of the ramp being covered with a layer of ice, so that electric contact was not made with the engine shoe. These questions will have to be examined by the experts, but, at the same time, indirect causes should not be overlooked. These, on one hand, include the fog and the corresponding lateness of the trains, and, on the other, the number of extra trains which were put into service to meet the Christmas holiday rush. In such circumstances, the sinister effect of the fog was a double one, at once rendering it not only difficult to observe the signals, but also difficult to make up for the time lost. Above all, it is quite certain that the collision would not have been so serious if the first train, like the second, had been made up of steel carriages.

Is it necessary to conclude, asks *Le Genie Civil*, that the whole occurrence is a reflection on the French railway system, and that the present signal system in particular needs to be rejected and replaced? Such a conclusion would be a grave injustice, and, at the same time, a mistake. The efficiency of the signalling equipment has been proved for long periods, and the number of the victims of the accident in relation to the millions of passengers carried by the railways is not in comparison larger

* Published by Libraire Beranger, and reviewed in *Le Genie Civil*, August 6th, 1932.

per annum than that for similar railway systems, while the safety of rail traffic is indisputably higher than that of the traffic on the roads. The problems which arise in connection with the collision at Lagny make it very necessary to examine what simple means can be adopted in order to avoid the recurrence of similar accidents, and not to consider extreme measures which may be more dangerous than effective.

In the matter of signalling special attention should be given to the need for increasing the strength of the signal lights, especially in the case of certain types of signals. The development of electric colour-light signalling on the automatic block system has solved the problem in quite a simple way, and the signals are much easier for the driver to observe. The perfecting of means for cab signalling in connection with this principle would call for research and study on the part of railways in order to ensure its thorough reliability.

Strict orders with regard to service conditions in zones in which dense fogs are likely to occur would possibly result in better arrival times. It seems likely that on specially busy sections of the line in districts in which fogs are frequent, special repeating signals, such as those used on the line between Brussels and Antwerp, should be provided. This particular line has heavy traffic with expresses, and is subject to severe winter fogs and possible heavy falls of snow. On it there are three repeating lights for the distant signals, and two for the home signals. The lights are fixed on small posts about 2·50 m. in height placed about 1·50 m. from the side of the rail, so that the lamps are approximately on the same level as the eye of the observer. The posts are spaced at 150 m. intervals, the last being about 150 m. from the signal repeated.

The results obtained with this system are very satisfactory, the running of trains being speeded up and the number of cases in which signals have been passed has fallen practically to zero. A similar installation would be practicable in sections in which fog was liable to be thick and where the extent of the traffic justified its use, above all if it were possible to ensure that the signals could be repeated in the locomotive cab.

The important point, however, to examine with regard to the Lagny accident concerns rather the means which can be used on days of heavy traffic combined with atmospheric troubles to ensure as regular a service as possible. It is useful in this connection to confirm that on normal days the working stops caused by signals are very rare, and this fact may be looked upon as pointing to one of the most essential factors in safe working. On busy days, such as holidays and similar occasions, the railways should arrange for an adequate service of extra trains so that they are not faced wth unexpected crowds of passengers with whom it is difficult to deal, thereby creating a condition which undoubtedly tends towards disorganised services. As regards movement of trains in stations, it is always difficult to carry out station operations in the exact interval between trains, especially when times are irregular, while stops before signals are then very difficult to avoid.

Railways might be freed from some of their more difficult obligations if measures embodying the following two proposals were to be adopted :—

(*a*) Advantages should be offered to those passengers who would leave for their destination one or more days before the rush days, so that, as far as possible, a very large number of passengers travelling on one particular day would be avoided.

(*b*) Advantages should be given to passengers who, desiring to travel on busy days, would book their seats twenty-four hours in advance. The railway authorities would then be better informed as to the number of passengers travelling and their times of departure.

These are some of the factors which certainly must not fail to be examined. Finally, it will be necessary to find financial resources which will permit the construction of steel rolling stock to be hastened on, so that the old wooden carriages which are very dangerous may disappear as soon as possible.

In conclusion, it may be stated that three exceptional factors combined to contribute to the cause of the accident at Lagny—the fog, probably ice on the ramp, and the disorganisation of the service caused by the large number of passengers travelling on Christmas Eve. Without searching further, it seems that it is to these three factors that attention should be given, probably in the following order :—The improvement of the signal lights, the ramps and the cab signalling apparatus, and the introduction of special orders relating to busy days of traffic which would prevent disorganisation of services.

ON February 3rd, says *Flight*, the fast fortnightly air mail service between Germany and South America started, when a Luft Hansa Heinkel H.E. 70 machine left Stuttgart, with 400 lb. of mail, at 8 a.m. for Seville, *en route* for Brazil and Argentina. At Seville the mail is transferred to a Junkers machine, which takes it to Las Palmas, whence it is carried to Bathurst (Gambia) by another aeroplane. Here it is transferred again to a Dornier "Wal" seaplane, which makes the service across the Southern Atlantic *viâ* the German floating station, the "Westfalen."

Canadian Engineering News.

(*By our Canadian Correspondent.*)

Engineers Aid Fisheries.

OPENING up channels in some river beds, building fishways, and removing stream obstructions in the Maritime Provinces and British Columbia, where the fisheries are administered by the federal authorities, make up a very important part of the work of the engineers of the Dominion Department of Fisheries. If this conservation work were not undertaken, then in some streams different kinds of fish which spawn in fresh water would be unable to make their ascent if they happened to arrive when the water was low ; in other cases falls would bar the way to the spawning grounds, and in still other streams obstacles of various kinds would prevent the fish from travelling along them. Quite often the work of making the way clear for fish on a spawning stream is not a big job, for an obstruction which effectively blocks the passage may, at the same time, be comparatively easy of removal. Sometimes, however, the engineer's undertaking is anything but a small task, as, for instance, in the case of a fishway on the Mersey River, in Nova Scotia, which was built to overcome a height of about 60ft., the greatest height overcome by any fishway in the world, so far as is known ; or in the case of the Stamp Falls fishway in British Columbia, which had to be cut out of solid rock. One or two references to work done last year may serve to indicate more clearly the different kinds of jobs that are done. On both the Roseway and Lequille rivers in Nova Scotia channels several hundred feet long were opened up to facilitate the ascent of fish during low water periods. To help salmon and other fish to get up the Medway River in Nova Scotia, an existing fishway was enlarged and channels were improved. A channel was opened through a gravel bar at the entrance of Trout River, Cape Breton, to permit the entrance of trout for spawning. Inspections and surveys of several streams in each of the three Maritime Provinces were made in order to determine necessary action to aid the passage of fish. In British Columbia a fishway was completed on the Kwalatie and Koksilah rivers, and work was done on some existing fishways. Obstructions of different sizes were removed from more than fifty streams in the province. A number of surveys and inspections were made, some for the purpose of investigating the effectiveness of fishways previously built, and others for the purpose of ascertaining what course it would be best to follow in overcoming difficulties in different streams. It is interesting to note, too, that an examination of fishways constructed in previous years, both in the Maritime Provinces and on the Pacific Coast, showed that they were operating efficiently, and that many fish which would otherwise have found it practically impossible to get to the spawning beds in the upper reaches of the rivers were successfully making the ascent.

Snow Removal Machinery.

The development of snow-removal equipment during the past few years has done much to cut down the actual cost of maintaining Canadian highways in winter. While it has been possible to remove considerable snow by graders and power maintainers, they have been found to fail when drifts of any proportion are met with, making it necessary to use trucks or crawler tractors fitted with snow ploughs, the "V" type plough with wings being greatly used. By the use of these machines it has been found possible to open a 20ft. to 24ft. roadway in a round trip. The bank of snow produced on the side of the road by this operation is then moved back beyond the shoulder of the road and spread as much as possible to prevent further drifting in case of another storm. When heavy snowfalls and much drifting occurs, it has been found advantageous to use a plough equipped with a blower. After the snow has been banked at the sides, the blower is brought into action and the snow is scattered to the sides and levelled off in this manner. Ice conditions have been dealt with on most of the main highways by sanding the hills and curves, and those places where deep ditches are situated at the sides of the roads. The difficulty of handling the sand has been greatly reduced by the use of calcium chloride, which is mixed in the proportion of about 30 lb. to the cubic yard of sand. This mixture is spread on the roads either by hand or by using a sand spreader attached to the rear of a truck.

Container Testing Machine.

Some interesting tests have been carried out on containers for Canadian manufacturers in the Forest Products Laboratories at Ottawa. These tests have been made to determine whether the strength of the container is sufficient to protect its contents. The strength of the containers is determined by means of compression, drop, and hazard machine tests. Of these tests, the last mentioned is probably the most interesting, as it simulates in a very short period the drops, blows, and puncturing effects received by the container in actual transportation. The machine, stated to be the only one of its kind in Canada, is 16ft. in diameter with interior floors arranged in the form of a hexagon. It is mounted on two sets of wheels which permit of its being revolved at a constant speed. The box to be tested is placed in the interior and the machine allowed to revolve. The box drops from floor to floor, and by means of guides is directed in such a manner as to fall on all sides, ends, and corners. Cone shaped hazards are placed on some of the floors to produce the puncture effect. From observation of the containers under this test, the weakest part in their construction is readily discovered. By means of trial and error, the container can then be so altered that it is equally strong in all parts. It is usual in carrying out these tests to have the container packed with the actual commodity for which it is designed. Tests have been made with this machine on containers varying from light egg crates to mowing machine crates weighing in the neighbourhood of 1200 lb.

Slave Falls Power Plant.

Two new units of 12,500 H.P. each will be established shortly at Slave Falls by the Winnipeg Hydro-electric System, at a cost of approximately 1,500,000 dollars. At the present time the entire output of the System's Point du Bois and Slave Falls plants, as well as the full amount of power called for under the System's contract with the Winnipeg Electric Company, is in use. Two-thirds of all this power is being used at the electric boilers of the civic central heating plant to generate steam.

Tin-plate Plant.

With reference to various recent items in the Press regarding the proposed manufacture of tin-plates in Canada by Welsh manufacturers, it is now definitely understood that Richard Thomas and Co., Ltd., have decided to proceed at once with the scheme. Space and facilities are understood to have been arranged for in the large plant of the Dominion Alloy Steel Corporation, at Sarnia, Ontario. The necessary equipment as well as a supply of raw material has already reached Canada, and experts have arrived from Wales to supervise the installation and operation of the plant. Richard Thomas and Co. recently made an application before the Canadian Tariff Board for a three months' adjournment of the hearing to decide the status for duty purposes of tin-plate. It was the view at that time that the projected Canadian plant to make tin-plate would be controlled by a group of the larger British manufacturers of steel products. Mr. J. A. Mann, K.C., who appeared before the Tariff Board for the Richard Thomas company, stated that that firm exported 93 per cent. of the tin-plates sent out of Great Britain. The other companies associated with it in the proposed Canadian enterprise manufacture a wide range of other steel products, and it is rumoured that the Canadian plant may develop into a steel industry of considerable proportions, making many products not formerly produced in Canada.

Railway Rolling Stock Industry.

How the railway rolling stock industry in Canada fared in 1932 is shown in a recently issued Government report. Production in that year was valued at 32,465,192 dollars, a decline of 52 per cent. from the total of 67,865,070 dollars in 1931. Corresponding totals for earlier years were 104,922,701 dollars in 1930 and 126,487,037 dollars in 1929. Only 282 new freight cars were made in 1932 and only two new locomotives. Two gas-electric passenger cars were produced and four electric railway snow ploughs, a few narrow-gauge mining cars, and some track motor car units. The value of repair work done on cars and locomotives was 18,925,135 dollars.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

SWITCHGEAR FOR INDOOR AND OUTDOOR INSTALLATIONS.

No. 162—1934. This is a revision and extension of the B.S. Specification for Electric Power Switchboards. It uses the term "switchgear" instead of "switchboards," and the scope has been enlarged to cover outdoor, as well as indoor, installations up to and including 220 kV. The original specification went up to 33 kV only, but two new sections deal with high-voltage and extra-high-voltage outdoor switchgear and with switchgear in kiosks. Extensive notes on isolation of sections and circuits and section delimitation are included. The latter are illustrated by a series of diagrams showing the application of the standard clearances and the use of screens, barriers, &c., for the delimitation of group-sectionalised and circuit-sectionalised switchgear

GROSS AND NET CALORIFIC VALUE.

No. 526—1933. Arising out of the resolution made at the London Fuel Conference in 1928, consideration is now being given by the International Standards Association (I.S.A.) to the setting up of international standards dealing with the definition of gross and net calorific values of solid, liquid, and gaseous fuels. The British Standards Institution accepted the invitation of the World Power Conference to undertake to present the British point of view as to what was the practice in Great Britain in regard to the definitions of the terms "gross" and "net" calorific value, and the way in which they were used.

The British Standards Institution decided that its recommendations, as forwarded to the I.S.A., should be issued as a British Standard in order that they might be given full weight in any international consideration which might take place, and the agreed standard definitions of "gross" and "net" calorific value of gaseous, solid, and liquid fuels have, therefore, been published as a British Standard at the price of 1s. 2d. post free.

STEEL EYEBOLTS.

No. 529—1934. This specification deals with steel eyebolts, such as are extensively used in the electrical and other industries. The design is original and was the subject of careful investigation and exhaustive tests at the National Physical Laboratory. Outstanding features of the design are that the eyebolts are for use with shackles only, are provided with a very substantial recessed collar, and have the screw thread relieved at the junction of the collar and the screwed stem.

The provision of a substantial collar adds materially to the strength of an eyebolt subjected to inclined loading, and investigation shows the necessity for smooth finish to the bearing surfaces, which should be in close and intimate contact throughout.

The specification deals with eyebolts from ⅜in. to 3in. in diameter and clauses are included dealing with material, workmanship, and tests. It is specified that all forging shall be descaled by pickling or sand blasting to detect defects prior to machining the collar and stem. Recommendations are given as to permissible safe working loads when applied axially or when the eyebolts in pairs are subjected to loading at an angle.

Railway and Road Matters.

THE "Royal Scot" train, now touring Britain following its visit to Canada and the United States, will, it is announced to-day, be exhibited at the British Industries Fair at Castle Bromwich, Birmingham, from February 19th to March 2nd.

ANSWERING a question on February 7th, the Minister of Transport said that he was informed that during the year 1933 the four main line companies constructed 936 passenger-carrying vehicles and that steel was used therein up to 75 per cent. of the total weight.

DESPITE the opposition to the London Passenger Transport Board's Bill, particularly in respect of the substitution of trolley vehicles for tramcars, the Bill was given a second reading in the House of Commons on Monday, February 5th, without a word of opposition.

THE coroner's jury which has been investigating the death of the four people killed in the Liverpool tramcar accident of January 3rd, returned a verdict of "Accidental death." They expressed the opinion that the accident was caused by the wheels of the car locking, but there was insufficient evidence to show how they became locked.

A FURTHER list, supplementing those referred to herein on January 12th last, has been published of the "agreed rates" to be submitted for approval to the Railway Rates Tribunal, under the Road and Rail Traffic Act. These are rates that generally have no limit as to distance, wherein rates for certain traffic cover the carriage, whether for near or far.

THE subject of level crossings was raised in a question in the House of Commons on February 7th, which gave Mr. Oliver Stanley an opportunity to state that well-considered schemes for the elimination of level crossings were eligible for grant from the Road Fund, and that he was always ready to receive applications from the responsible highway authorities for projects of that character.

THE new President of the Institution of Railway Signal Engineers is Mr. Ralph S. Griffiths, one of the engineers of the Westinghouse Brake and Saxby Signal Company, and formerly of McKenzie and Holland, of Worcester, whom he joined forty years ago. The subject of his Presidential Address on Wednesday evening last was the History of the Locking Frame, wherein some forty types of interlocking were mentioned.

THE incident at Reading, Great Western, Station on Wednesday, February 7th, when a barrow loaded with milk churns fell on the line, and was run into by an express, without, however, any serious injury, carries the mind back to the serious disaster of September 2nd, 1898, at Wellingborough, Midland Railway, when a luggage lorry fell off the platform on to the line in front of an express from St. Pancras to Manchester. The train was derailed and wrecked, and five passengers and two servants were killed. Escaping gas caused a fire subsequently to break out. The Board of Trade report on the accident recommended that luggage lorries should have brakes, and that platforms should slope from the line; previously it was the custom to slope them towards the line, so that any rain would run off.

AN unusual feature of the thirteen fatal accidents to railway servants mentioned herein on February 9th was that four of the men killed were firemen. One was engaged on the engine of a passenger train from Perth to Glasgow, L.M.S.R. At a certain point of the journey, owing to the line falling almost continuously, he was practically free from footplate duties. Just before entering Kippen-cross Tunnel, between Dunblane and Bridge of Allan, the driver noticed the man standing on a small raised portion of the footboard immediately behind the trailing wheel splasher on the fireman's side, with his back against the hand rail pillar. Shortly after emerging from the tunnel, the driver missed his mate, whose body was subsequently found in the tunnel. Soon after entering the tunnel there had been a sudden back-draught with a momentary burst of flame from the fire-hole door, and it was surmised that that caused the fireman to flinch or even try to step back, and that he overbalanced over the cab door, which was closed. Mr. J. L. M. Moore, in reporting on the accident, says that the raised portion is an innovation that is being added as the engines pass through the shops. It does not in any way improve the fireman's view, but, as a foot rest, adds to his comfort when using the splasher as a seat. As, however, the raising of the footplate level by 10in. considerably reduces the safety effect, its desirability should be investigated.

Two pages of the 1932–33 annual report of the South African Railways deal with the question of road motor transport *versus* rail transport. Mr. Watermeyer, the general manager, observes that the frequent reiteration of the statement that road transport is more economical than rail transport, makes it necessary to state that, as far as South Africa is concerned, that is not so. By that, of course, is meant the cost of performing the service, and not the rates charged. On the South African Railways the average cost, including interest, of conveyance of goods, coal, and live stock, is less than 0·9d. per freight ton-mile. That is for bad loads and good, and covers the empty haulage necessary when the traffic is not balanced in both directions. The Railway Administration also operates 9928 route miles of road-motor services, and the average cost of these services is approximately 4d. per freight ton-mile. The answer to the argument that a private organisation would operate the road services more cheaply is that the Administration enjoys the advantages of lower prices for motor vehicles, petrol, tires, and spare parts. It is very important to remember that railway costs included interest on the capital cost and maintenance of the permanent way and buildings. The diversion of traffic to the roads would involve the State in the expenditure of millions for construction and maintenance of roads. Any such diversion would not permit the Railway Administration to effect corresponding economies in working expenditure, as a large proportion of it, such as interest charges, depreciation, maintenance of the permanent way, and overhead charges, would not be appreciably reduced as a result of less traffic.

Notes and Memoranda.

A NEW type of anchor having only one point and no cross bar, resembling a double-bladed ploughshare, has been designed by Professor G. I. Taylor. It has been shown by tests to have at least twice the holding power in proportion to its weight of any existing anchor.

CASTINGS in the South Milwaukee plant of the Bucyrus-Erie Company are now being cleaned of core sand, &c., by washing with water at a pressure of 300 lb. to 400 lb. per square inch. The casting is placed in a special steel room, 25ft. square, with a 12ft. rotating table in the centre, and the water is sprayed from two nozzle stations in one corner of the room. Shatter-proof windows directly above the nozzles permit the operator to see the work and direct the nozzles wherever required. At both stations the operator has control of the water pump, work table movement, nozzles, and the interior lights. The water employed in the washing process is used again and again.

DEALING with the purification of fine coal, in a lecture before the Society of Chemical Industry, Dr. Sinnatt pointed out that at the Fuel Research Station the vacuum flotation treatment of certain coals had been greatly improved by the addition of coagulating agents which caused the precipitation of the fine impurities which might otherwise be carried over with the coal. In the vacuum flotation process the coal separated as a froth, which, when the pressure was brought to atmospheric, collapsed and yielded a product which drained rapidly. He also described an ingenious settling tank which worked on the principle of an inclined test tube and separated the coal into particles of different size.

IN the *Machinist* Mr. E. S. T. Hill gives the following useful method of making the matched patterns for engraving male and female dies. The male pattern is cut in a strip of steel of about 0·4 carbon to give the required hardness. This is fastened to the face of a special blank, drop-hammer tup. Below this is placed a strip of soft copper, lying on a polished block and enclosed at the edge by a steel frame which takes the standard blanks. One or two blows are given and the copper is then roughed out with hammer and chisel, annealed, and restamped. One more trimming, annealing, and stamping generally finishes the job. The pair mate perfectly and the copper is very hard after the cold stamping.

FOR concrete piles which have to stand the effect of disintegrating waters or soils, impregnation with asphaltum on the vacuum method is recommended by Mr. B. Price Davies in the *Builder*. This treatment is very similar to the impregnation of wood. The casing of concrete or its surface treatment can assist in making it waterproof. The writer successfully lined the base of water filters with slate slabs an inch thick and jointed them with bitumen. In the same way concrete can be lined with marble, asphalt and semi-vitreous tiles jointed in bitumen, but the advantage of slate is its impermeability, its density, its small expansion movement, and its availability in large areas. The surface treatment of concrete or cement renderings with bituminous emulsion can be recommended, particularly for marine work.

A NEW process for the manufacture of liquid fuels containing a very high percentage of alcohol is being worked by the Societa Carburanti Italia, of Milan. The new process is described by S. Doldi in the *Giornale di Chimica Industriale ed Applicata*. The fuel produced is termed "Carburante Italia," and is made by thermal decomposition. For instance, a mixture of 32 parts of methanol and 68 parts of crude benzole is taken. This mixture, of which only 23 per cent. distils up to 60 deg. Cent., is quite unsuitable for ordinary motor engines. By passing the mixture in fine spray through iron cylinders heated to 500 deg. Cent. and rapid condensation of the vapour a product is obtained of which 42 per cent. distils up to 60 deg. Cent. and which is very satisfactory as a motor fuel for ordinary use. Losses in the process are given as 3 per cent. at the most and 1 per cent. in ordinary practice. Benzole can be replaced by cruder tar oils, whilst products with an alcohol content as high as 70 per cent. can be obtained.

AN interesting scale model of a gasworks, designed to supply a town of 200,000 inhabitants, has been presented to the Science Museum by the Gas Light and Coke Company. It stands in the entrance hall and will form a central key to a larger exhibition of modern gas manufacturing apparatus. It has taken over two years to make, and has cost about £1400. The model measures 6ft. by 3ft. 8in., and is approximately one-hundredth of the actual size of an up-to-date gasworks capable of a daily output of 5,000,000 cubic feet of mixed coal gas and carburetted water gas. It illustrates all the processes in the production of gas. The lay-out has been devised not only to show a practical method of placing the different buildings in relation to one another, but for the convenient demonstration to students of carbonising, gas purification, carburetted water gas manufacture, and gasholders. The important parts of the plant are shown in part section, so that any piece of plant may be easily recognised in a larger sectional model.

ABRASIVE cleaning of billets 4in. by 2in. by 30ft. long, at a plant in the Great Lakes district, has, says *Steel*, effected a reduction in costs compared with pickling. The equipment employs centrifugal, tangential, and aerodynamic forces rather than compressed air in impinging the abrasive against the work being cleaned. The machine consists essentially of a revolving wheel which throws an abrasive from vane outlets at its circumference against the billets, which move beneath through an enclosed chamber. Introducing the abrasive below the centre of the wheel causes the bulk of it to be thrown downward upon the steel when ejected rather than upward. The billets are fed into the machine on motor-driven rolls at a speed of about 60ft. per minute. The capacity of the unit varies, but in this instance more than 200 tons of steel has been cleaned in ten hours. In cleaning the billets, No. 38 grit, crushed cast shot is found to be most suitable. Less than 4 lb. of the abrasive shot is consumed per ton of billets cleaned. This method of cleaning billets is claimed to facilitate the subsequent chipping process, as well as to increase its speed by making surface defects more discernible.

Miscellanea.

THE Russian coal output in 1933 totalled 76,700,000 metric tons, or 12 per cent. more than in 1932.

OIL has been struck near Hanover, Germany, and is said to be gushing at the rate of 10 tons daily.

THE new drainage scheme for Falkirk and district, provided at a cost of some £123,937, has been inaugurated.

A RECENT report states that the number of motor cars and commercial vehicles produced in Canada and the U.S.A. during 1933 was 2,048,000.

Two blast-furnaces are restarting at Normanby Ironworks, Tees-side, and one at Consett, Co. Durham, making twenty-six in action on the North-East Coast.

IT is estimated that a full year's working of the Manchester gasworks benzol-recovery plant will produce 643,000 gallons of benzole and solvent naphtha.

THE Dundee Gas Committee is to spend £7500 on installing a crude benzole-recovery plant at the city's gasworks. The estimated annual production of benzole is 214,173 gallons.

DURING 1933 the number of motor cars made for use in Canada was 43,178, and the number made for export 22,746, says a report issued by the Dominion Bureau of Statistics, Ottawa.

AFTER negotiations extending over many years, the London, Midland and Scottish Railway is to proceed with the building of a new station entrance and a new hotel in front of City-square, Leeds. It will cost £500,000.

FRENCH engineers and miners who are engaged in boring operations in the Arigna Valley, Co. Leitrim, under the auspices of the Free State Ministry of Industry and Commerce, are stated to have struck three rich veins of iron ore.

WE are informed by Messrs. Coode, Wilson, Mitchell, and Vaughan Lee that the final date for receiving tenders for the Kut Barrage and works is at noon on May 5th, at Baghdad, and not on April 5th, as stated in our last issue.

AFTER reaching a height of 13 miles, the Soviet balloon "Osoaviakhim" crashed when descending. The crew of three were killed and all the instruments were destroyed. The crash took place nearly 350 miles from where the ascent commenced.

ANSWERING a question in the House of Commons as to the number of people killed or injured in British aeroplanes as a result of collisions with wireless masts, high-tension cables, or other high obstacles, Sir Philip Sassoon said that during the last five years there had been two such accidents to civil aircraft flying in this country. These involved injuries to two persons.

THE Korea Nitrogen Company has, according to the *Chemical Trade Journal*, decided upon the erection of a large coal hydrogenation plant at Eian, in the North of Kankyo Province. The company is to be granted a subvention for seven years amounting to 170,000 yen in the first year and 380,000 yen in the subsequent years. The company expects to produce about 500,000 tons of liquid fuel in the year 1935-36.

A LARGE new electric power station is being built at Darien by the South Manchurian Electric Company in conjunction with a new chemical works for the Manchurian Chemical Industry Company. The contract for the first 25,000-kW turbo-generator set for the new station has been secured by the Brown-Boveri Company. The turbine is of the three-cylinder type, and is being designed to run at 3000 r.p.m., and operate with steam at a pressure of 34 atmospheres, and at a temperature of about 800 deg. Fah.

A CONFERENCE of the International Air Traffic Association has been held in Berlin, at which representatives from thirty nations, controlling 60,000 miles of regular air lines, attended to arrange the summer time-tables of the great network of European airways. Arrangements are being made for the air lines of all nations to interconnect, and it would be possible this summer to book a through ticket by air from London to 150 Continental cities and towns, the majority of which would be reached in a single day from London.

ACCORDING to the *Journal of Commerce*, the United States Senate Appropriations Committee has approved the Administration Bill setting aside £190,000,000 for unemployment relief and for the civil works administration for the remainder of the current fiscal year. During November, according to the Federal Relief Administration, more than 15,000,000 persons received public unemployment relief. The latest figures available show that 10,826,000 persons were unemployed during December, but of these 4,000,000 are temporarily engaged on Government relief projects.

THE Imperial Institute has recently published a set of Grading Rules and Standard Sizes for Empire Hardwoods (Square-edged), prepared by the Advisory Committee on Timbers of the Institute, and recommended by them for use in dealing with consignments of these timbers shipped to the United Kingdom. The Grading Rules have been approved by the Hardwood Section of the Timber Trade Federation of the United Kingdom and the British Standards Institution has agreed to the circulation of the Rules pending consideration of them for inclusion in the National Specifications for Timber which the Institution has in preparation as an outcome of the Ottawa Conference.

NEGOTIATIONS for the prolongation of the German cable syndicates have made such progress that it is expected a favourable result will be reached before the end of March, when the existing agreements, which were extended in 1930 for a period of four years, will nominally expire. The combinations concerned are the Low Tension Syndicate and the Association of high-tension cable works. Including the four large firms (A.E.G., Siemens, Bergmann, and Brown-Boveri), the syndicates comprise twenty-two works, and practically represent the whole of the German production of low and high-tension cables. The syndicates are price-controlling combinations, and each member has a definite quota in the total sales business that is transacted.

THE AIR MINISTRY SEAPLANE TESTING TANK AT FARNBOROUGH

(*For description see page* 166.)

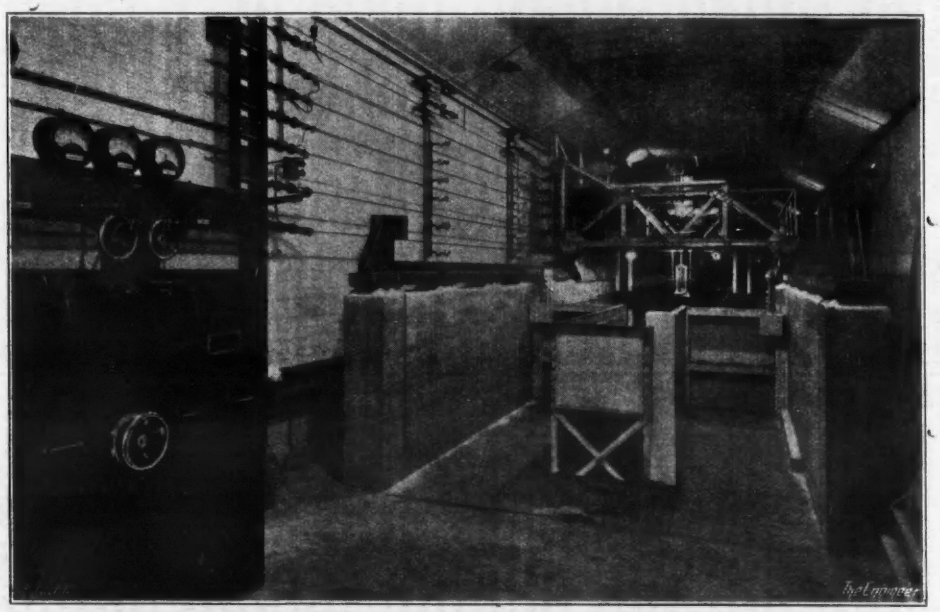


FIG. 4—VIEW OF TANK BUILDING FROM DOCK END

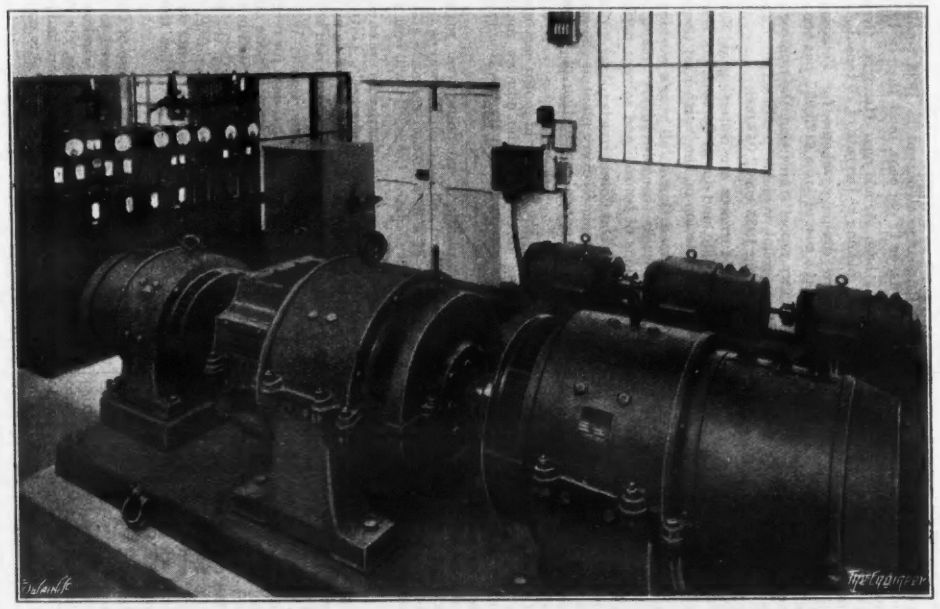


FIG. 5—THE MACHINERY ROOM

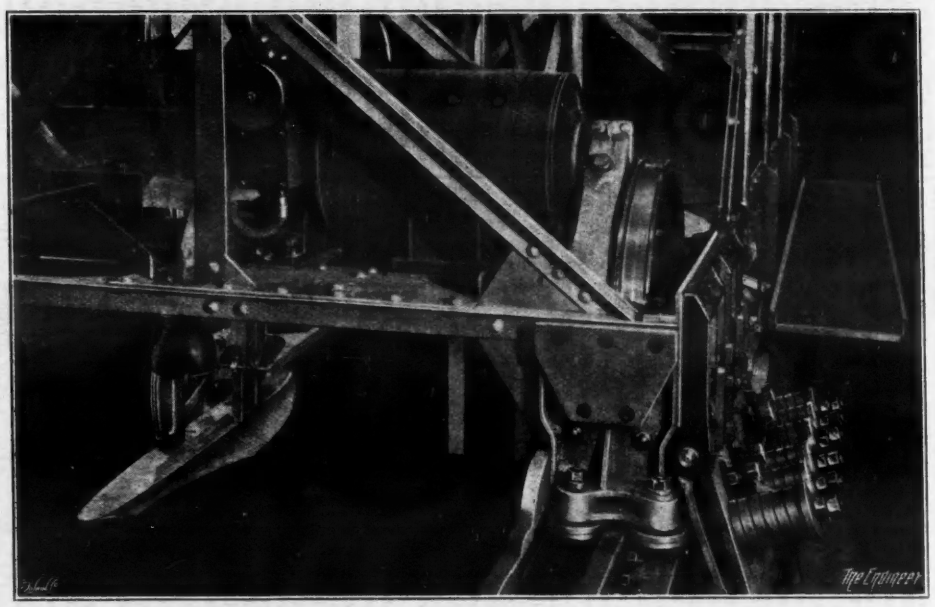


FIG. 6—CARRIAGE DRIVING UNIT

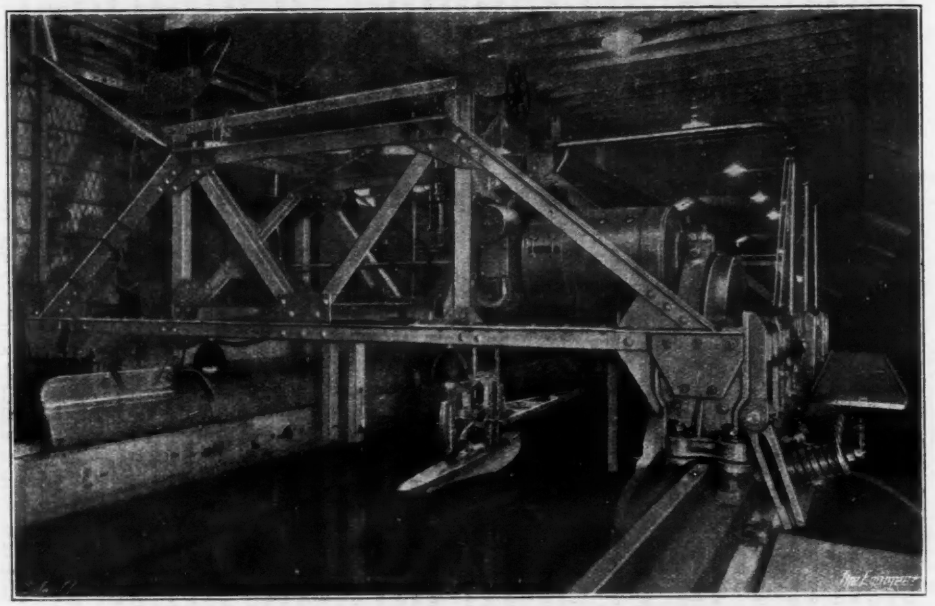


FIG. 7—GENERAL VIEW OF CARRIAGE

The Engineer

FEBRUARY 16, 1934.

VOL. CLVII. No. 4075

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NOTICES TO READERS.

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The British Industries Fair.

With this number is included a special eight-page Supplement devoted to the Engineering section of the British Industries Fair at Castle Bromwich, near Birmingham. The Fair has now grown to such dimensions that we cannot deal with all the engineering exhibits, but we endeavour in the present Supplement and in another which will appear next week to cover those which appear to be of greatest interest to our readers.

ANNOUNCEMENT.

"THE METALLURGIST."

Owing to the publication of a special Supplement on the British Industries Fair on February 23rd, the next number of THE METALLURGIST *will be published with our issue of March 2nd.*

THE NEW CUNARDER.

As we foreshadowed in a Journal note in last week's issue, the negotiations which for some time past had been going on to merge the Cunard Steam Ship Company, Ltd., and the Oceanic Steam Navigation Company, Ltd., were approaching a stage at which a public announcement could be made concerning them. That announcement was made in the House of Commons on Thursday, February 8th, when, in answer to a question put by Mr. Kirkwood, Mr. Hore-Belisha, the Secretary of the Treasury, speaking in the absence of Mr. Neville Chamberlain, outlined the conditions under which the Government was prepared to advance to the Cunard Company and to the merger company the necessary money for the immediate completion of "No. 534" at Clydebank, and for the working expenses of the merger company. The conditions under which assistance would be given for the building of a sister or sister ships were also outlined. This decision has given general satisfaction, for it is felt that, despite doubts as to the economics of such large vessels, the building of these liners will mark an important step in our industrial recovery and will greatly increase our national prestige. In a White Paper issued shortly after the parliamentary statement further details of the agreement are set forth. The merger company, which is always to be and to remain under British control, will be called Cunard-White Star, Ltd. Its board will consist of ten members, including the chairman, six of whom will be nominated by the Cunard Company and four by the Oceanic Navigation Company in proportion to their shares of the capital. On the Treasury side the particulars are as follows. In order to provide the requisite finance for the completion of "No. 534" the Treasury will make allowances not exceeding £3,000,000 in three equal sequences, one to the Cunard Company and two to the merger company, provision being made for adjustment should the cost of completion be less. The Treasury will also advance from time to time to the merger company sums not exceeding £1,500,000 to provide that company with the requisite working capital. Legislation is shortly to be laid before Parliament with a view to conferring on the Treasury any requisite powers to give effect to these financial arrangements. Such legislation will also give power to the Treasury to advance in its discretion to the merger company the cost, not to exceed £5,000,000, of an additional new ship, on terms analogous to those to be made towards the completion of the construction of "No. 534." The advances will all be secured by the issue at par of debenture stocks.

In these happy circumstances there seems to be every likelihood that work will be resumed at Clydebank next month, which should permit the liner to be launched before the end of the year. The completion of this great ship has hung upon the yellow light for upwards of two years, uncertain whether the signal was to turn green or red. In those two years the technology of ship propulsion has not stood still, and if certain problems have been removed others have been added. When the new Cunarder was laid down the internal combustion engine and turbo-electric propulsion demanded close scrutiny. But in the two years that have elapsed nothing has occurred to give either of those means of propulsion an outstanding superiority to the geared turbine drive. Neither has the use of powdered fuel at sea made such advances that it requires reconsideration. It may be said also that ship design, as far as hull form is considered, and as far as vessels of the Cunarder class are concerned, has undergone no marked changes. Hence we may take it that the ship will be propelled by steam turbines driving propellers through gearing and provided with steam by oil-fired water-tube boilers. In other words, the propelling plant will be of orthodox steam design. But that does not mean that the plans settled three or four years ago call for no revision. In that period considerable advances have been made in turbine design which call for attention, and especially in boiler design and operation. Higher pressures, and particularly higher temperatures, are becoming general, and the steaming capacity of boilers for a given weight and space has advanced notably. Thus the designs of over three years ago will have to be brought up to date, even though some of the equipment already made must be modified or sacrificed. For it is the duty of the new Cunarder to win back the blue riband of the Atlantic. In the opinion of many well qualified to speak that is her sole *raison d'être*. It is questionable whether she, even with a sister, can be operated as a profitable financial investment. She must be run at a high speed even if no more than a few hours are to be gained thereby, and high speed means great power. The economical speed of passenger liners has, we believe, never been settled precisely, but there is little or no doubt that in this instance it will have to be exceeded simply and solely for the purpose of securing to this country a prestige which all are agreed is of quite incalculable value. It is, in brief, to the invisible profits that we must look for justification of the action being taken by the Treasury.

The immediate competitor of the Cunard-White Star ship will be the "Normandie," of the French Line, which was recently dry docked for fitting propellers and is now well advanced both as regards hull and machinery construction. Her engines comprise a four-shaft arrangement of turbo-electric machinery taking steam at about 400 lb. pressure and at over 700 deg. Fah. final temperature from oil-fired water-tube boilers. From figures already published there appears to be but a small difference in the dimensions, displacements, and machinery outputs of the rival ships, the hull lines of which are acclaimed by their designers to be the best possible for Atlantic traffic. About one hundred hours will be required to make the voyage of nearly 3000 miles from Southampton to New York at a speed of, say, 30 knots, so that an increased speed of, say, one knot or even two will make but a few hours' difference in arrival. That increase, however, can only be gained and maintained by a large reserve of power. If the Cunard-White Star liners are to regain the blue riband for Great Britain, their regular service performance must be no uncertain one in the matter of speed. There are, we know, leading firms of shipbuilders and engineers which, if they were asked to tender for the construction of the sister ship to "No. 534," would produce a design embodying new features of hull design and increased clear deck space, and an improved boiler, turbine, and auxiliary machinery lay-out which would incorporate many new technical features and would embody the advances recently recorded in the design and operation of both naval and liner propelling machinery. It must be borne in mind, however, that the main part of the boiler, turbine, and auxiliary machinery for "No. 534" was nearly completed two years ago. Between the preservation of the design of the machinery lay-out as first planned, and the adoption of the advanced designs above referred to, there is, we feel sure, a mean course of action which will make use to the full of all the valuable new features which can be incorporated within the limits imposed by the existing design. We may be quite sure that such a course will be taken by the builders' and owners' technical staffs with a view to making the ships the very best that can be turned out by British shipbuilding yards with the highest traditions behind them.

Steel Industry Reorganisation Problems.

THE reorganisation of the British iron and steel industry seems in danger of becoming a political rather than a business question, and that is a change that would be a tragedy for the steel trade, and a very bad thing for the country. It is useless to blame any section of the industry or the Government for the way in which the problem has developed. Each party to the controversy was called upon at short notice in unfamiliar conditions to deal with an industry that had been almost wrecked in a one-sided struggle under a fiscal system that has few supporters to-day. The industry was granted a generous measure of protection; but the Import Duties Advisory Committee made it plain that the continuation of the duties was contingent upon its carrying out a satisfactory scheme of reorganisation in which the interests of consumers were properly safeguarded. The National Committee was set up and produced a scheme, which, apparently, was favourably received by the Advisory Committee, but was not approved by the industry. For many months the National Committee worked upon its plan to make it more acceptable to the industry, and last December brought forward a modified scheme, and asked for its approval by the National Federation of Iron and Steel Manufacturers as representing the British steel industry. The new proposals have not been officially published, but have been dealt with in our columns at sufficient length to give a fairly complete indication of their scope. Briefly, they provide for a wide system of trade associations governed by a Central Council, upon which sections of the industry will be represented, and which will be presided over by a paid Chairman. The Associations are to be held together by a system of interlocking rebates designed to bind individual firms to the scheme. Directly details of the new scheme were disclosed it became apparent that many important branches of the steel industry regarded it with apprehension, and both in public speeches and in letters to the Press prominent leaders of the industry have not hesitated to call attention to its defects. At the same time, other leaders, equally well known, have given it their support, whilst individual firms have been the recipients of strongly worded letters from members of the National Committee urging its acceptance. In an atmosphere thus superheated by controversy, it will come before the National Federation of Iron and Steel Manufacturers at its general meeting on February 22nd; but its fate is likely to be decided before then by discussions amongst groups of steel makers and re-rollers in the producing districts, and at meetings of associations

which, ironically enough, in some cases have come into existence to function as part of the scheme.

So involved has the situation become that a clean-cut decision by the National Federation of Iron and Steel Manufacturers will present considerable difficulty. The Government is stated to have intimated to the National Committee through the Import Duties Advisory Committee that the discontinuance of the duties when they are due for renewal in October will be a real issue if the industry does not speedily adopt a scheme for reorganisation. At the same time, a letter sent recently by the Advisory Committee to members of the National Federation indicated that it recommended the acceptance of the National Committee's scheme. When matters had reached this stage, Sir William Firth exploded a mine by publicly declaring that it was "a comfortable and profitable scheme which would do nothing to reduce the costs of production, but would eliminate price competition in the home trade," and he pointed out that it did not provide for the elimination of obsolete and redundant works. Naturally, the scheme was defended by Mr. Charles Mitchell, the Chairman of the National Committee; but later it was attacked in the Press by Captain L. D. Whitehead, Chairman of one of the most successful re-rolling concerns in this country. It became clear, therefore, that it was problematical whether the scheme would be accepted by the industry as it stood, and, moreover, that in spite of the official exhortations which have been addressed to the Committee, in common parlance, to "hurry up," there was a prospect that its work wholly or in part would have to be done over again. Then Sir John Beale intervened and in a letter to the Mayor of Cardiff drew attention to what is perhaps the most important aspect of the situation. He pointed out that although the Bankers Industrial Development Company had agreed to provide the finance upon reasonable terms to enable the plans for the reorganisation of Guest, Keen and Nettlefold's Dowlais works to be put in hand immediately, he had received a letter from the Import Duties Advisory Committee which "explicitly contemplates the possibility that the duties will not be extended, and indicates that in any event there must be long delay before a decision upon the matter is reached by the Government." It is a singular situation in which our most important steel-making firms are encouraged to undertake great projects of development and construction under the protection of a tariff, and at the same time are threatened with the withdrawal of that protection unless a scheme is adopted which, in the opinion of many practical and experienced industrialists, is unsuitable for effecting the object in view.

The National Committee's plan is concerned with marketing and selling, and does not include provisions for financial reconstruction or industrial reorganisation directed to the cheapening of production. A further objection which has some justification is that the close-knit organisation proposed would place the destinies of important steel companies and even groups of companies under the direction of a comparatively small committee which might not be fully acquainted with their requirements. Eight months will elapse before the duties are reviewed, and it should not be beyond the abilities of men such as those who have been prominent in the controversy to design machinery which would inspire confidence, even if much of the present plan has to be scrapped. The existing scheme is bureaucratic, and is therefore unlikely to encourage the development of the industry; it seeks to create a condition in which consumers will have their suppliers, terms, and prices dictated to them, and in this respect is a denial of independent tradirg; and it is so complicated that in practice it will most certainly be found unworkable. Those who have with infinite labour evolved the existing proposals are worthy of a generous measure of sympathy if their work does not prove acceptable; but they commenced building before they or the industry were familiar with the conditions of a highly protected market, at a time when the thoughts and energies of everyone in the steel trade were concentrated upon the new commercial outlook. In these circumstances it is, perhaps, not surprising that their ideas of reorganisation turned chiefly to the selling rather than to the manufacturing side of the problem. A fundamental change in the present plan will require time to work out, and if it is to be made satisfactorily must be undertaken by men engaged in the industry who have also to conduct their own businesses. For this reason the threat to withhold the extension of the duties for another period should not be pressed too hardly upon the industry. Another aspect of the matter, however, must be considered. Recently the prices of pig iron, semi-finished, and finished materials have been considerably advanced, and it is no secret that discussions are taking place with Continental suppliers with a view to limiting by agreement the quantities of semi-finished steel which may be brought into this country. Consumers naturally resent the attitude of the steel makers in taking advantage of the protection which the Government has given them to attempt to control their supplies, and this raises a question which verges upon the political, and is also of vital importance to the re-rollers. Captain Whitehead has declared that "there is in this country only one really modern billet mill, and the output [of billets] is produced in plants which are, with a few exceptions, totally unsuited to the purpose." This assertion has not been contradicted, and it is doubtful after the disclosures which have been made if any Government could accept a scheme which does not allow commercial freedom to the trades included in the term "the iron and steel industry," and at the same time provide for a reorganisation of which Guest, Keen's Dowlais plan is a good example.

Literature.

Steel-makers. By HARRY BREARLEY. London: Longmans, Green and Co. 1933. Price 5s.

THE opening words of Mr. Brearley's preface to this delightful little book almost constitute a complete review of it. They show at once what manner of book it is, and we may say at once that "for those that like this kind of thing, this is just the kind of thing they will like." This is what he writes: "The letters comprising this booklet have been gathered together for publication because the manufacture of crucible steel is waning in favour of something cheaper, and in many respects not so good, and in appreciation of men, typified by my father, who have exerted a greater favourable influence on the practice of steel-making than they are given credit for. Such men exist nowadays, but they are not encouraged; on the contrary they are discouraged by the fashionable conviction that scientific control is a profitable and well-nigh complete substitute for experience and good judgement."

The reader will guess at once from these words that these "letters"—a literary artifice, for they have no appearance of ever having been addressed to anyone—deal with men and the ways of men in the making of crucible steel. They will also guess that Mr. Harry Brearley, despite his scientific training and his attainments as a metallurgist, still believes in human judgment and experience. Here is a curious example which we take from a chapter on "Teemers"—the autocrats of the furnace gang. Our author is speaking of the cabalistic symbols chalked on ingots by the teemer to indicate its "temper." "Old steel-makers who never realised the changes in their trade which applied chemistry was making, and who for half a century had observed minute differences which are not to be seen by a younger generation, even through a microscope, will relate how so-and-so could tell from the fracture of ingots whose temper was the same, what kinds of iron had been used in their making. . . . When I was fancying myself as an analyst, I made a collection of ingot ends and submitted them, whilst their fractured ends were still untarnished, to men whom I knew to be capable. One after another, these men arranged them, apparently without difficulty, always in the same order of increasing hardness." Furthermore, two of the men who knew about carbon content expressed themselves in terms of carbon, and their figures varied never by more than 0·03 from the laboratory determination. It sounds uncanny; it sounds like a page from "The Road to Endor;" but probably Mr. Brearley is right in thinking that in fifty years of daily experience one becomes endowed with exceptional power of seeing things.

We have given that story, out of its order, to whet the readers' appetite. We now go back to the beginning. The first "letter" is about the furnace. It is descriptive in a conversational way, but conveys a better idea of what a crucible furnace is and does, and how it has to be tended, than a text-book description.

It is followed by a couple of chapters on "Pot-making" and "Raw Materials." In the latter Mr. Brearley follows Percy in defending the name of J. M. Heath, who in 1839 took out a patent for the introduction of manganese into cast iron through the medium of a carburet—actually a compound of black oxide of manganese and baked tar. Others have forgotten, but old steel makers still remember the drama of that invention; the opposition of a group of steel makers; litigation lasting over fifteen years; the death of the inventor; and the judgment given against his widow. Speaking of "pots"—clay pots, that is—our author says: "A well-made clay pot is worth looking at; it is shapely, symmetrical, and excellently adapted to its purpose. To the man of informed imagination, a row of them in mid-air along the furnace walls, illuminated by the red light from the glowing furnace in the dusk of a December afternoon, is a picture worth recalling." The artist may see pictures like that; it is his business to. But when one who has himself been a worker amongst the pots, who has been so familiar with the scene that, were he an ordinary man he could not see it, when such an one can paint a tiny sketch such as that we have repeated, we understand the sympathy with the passing age that he has retained.

The *leit-motif* of the next few chapters is Beer. They deal with Cellar-lads, Odd Men, Pullers-out, and Teemers—all true servants of the hop, with the Cellar-lad as Ganymede amongst them. Mr. Brearley began as a cellar-lad at the age of eleven or twelve, with his father, the steel maker, on the floor above. He writes of the boy's duties with an inner knowledge and from intimate experience. One would hardly expect that so much could be said, and so attractively, about "lids" and "stands" of clay, or that the making of such things is no mean craft. But, amongst his duties, "First and foremost the lad carried ale for the workmen, whose consumption of this beverage was on the average very high, and in particular cases phenomenal. . . . Ale might have been regarded as one of the raw materials of steel-making. . . . To fetch ale was not a great job, but I noticed that it was not always the man drinking least ale who was most able at his job, most agreeable in his manners, or most generous in his disposition."

The "letter" on "Pullers-out" ends with a story which will amuse metallurgists. Mr. Brearley is writing of the risks which are run with cracked pots. "Many a puller-out," he says, "has had a 'sup of steel' inside his clog, and the wonder is it so rarely happens. One of them said to me a few years ago: 'Tha't interested in testing steel, but ah'll tell thi abart a test for 'igh speed steel tha asn't tried. When tha gets a sup o' steel i' thi clog, it taks some time for t' soor place to 'eal up; if it 'eals up nice an' red, it might be any sort o' steel, but if it 'eals up blue, tha can bet it war 'igh-speed; thee try it!'" Despite the concluding admonishment we suspect that this identification test *in corpore vili* will never become really popular in works laboratories.

With a chapter on "Bosses" we leave the directly human elements in Mr. Brearley's letters and find ourselves deep in a couple of technical questions—the importance of the metallurgical laboratory and the value of machining tests of tool steels. It is not surprising after what has preceded to find our author less eulogistic about the laboratory than many of his brother-metallurgists. His attitude is one of caution. "As a supplement," he writes, "Metallography is excellent; as a superseder of the older forms ot observation and deduction, it may not be so excellent—it may be misleading." He gives as an example of the danger of chemistry the still accepted statement about red-shortness. "I have seen," he says, thousands of tons of red-short steel crack or go to pieces in mills and forges, but cannot recall a single instance of a piece of commercial steel owing its red-shortness to sulphur." Pursuing his attachment to observation, he urges that there should be no barrier whatever between the works and laboratory facilities and laboratory methods.

His letter on Products, which turns not a little upon the Taylor-White revelations, will be read and approved by all who have had any experience of tool testing by the turning-an-ingot method.

The last of the letters is devoted to Industrial Education. In it, as in all that has preceded it, Mr. Brearley, both directly and indirectly, insists on the value of the experience gained in the shops themselves. He is not a disbeliever in education, any more than in science, but he is, manifestly, convinced that daily acquaintance with steel in all its stages, from the "pot" to the finished tool, is in itself a liberal education for a steel maker.

The charm of the book lies in the earlier letters, but it is consistent from end to end, and there is more than enough in it to keep steel masters, metallurgists, and even engineers, "argufying," for a twelvemonth.

The Crystalline State. Edited by Sir W. H. BRAGG and W. L. BRAGG. *Vol. I., A General Survey.* By W. L. BRAGG. G. Bell and Sons, Ltd., London. Price 26s.

THIS volume is the first of three which are designed to cover the subject of the microstructure of solids. In this country Sir William and Professor W. L. Bragg have headed the X-ray researches which have led to a new understanding of the solid state; their

present work will not be the least valuable of their contributions.

The peculiar power of the X-ray methods is based on three considerations; first, that X-rays are characterised by a regular repeat or wavelength; second, that a crystal is characterised by the regular repeat throughout its volume of a unit pattern of a few atoms; and third, that the magnitude of the two repeats is of the same order. As a result a beam of X-rays is scattered by a crystal into a system of diffraction spectra. In the crystal Nature has kindly provided a three-dimensional diffraction grating. Knowing the grating constants, we can measure X-ray wavelengths; conversely, knowing the X-ray wavelengths, we can determine the interatomic distances in crystals, and with the help of Professor Bragg, actually fix the atomic arrangement. Add to this possibility the fact that practically all solids are crystals or aggregates of crystal grains, and we see the potentialities of the method. We see, too, the reason for the intensive developments and applications which followed Laue's initial experiments in 1912.

It is the outcome of these activities which Professor Bragg now surveys. He picks out skilfully the principles of the crystal state and of X-ray "optics" and he describes in detail the way they have been extended, and applied to structure determinations. The main structure types are reviewed, and the contributions of this knowledge to the problem of interatomic binding is discussed. The account of more practical aspects of the properties of polycrystalline metals and alloys, as, for example, the effects of internal stresses produced by cold work and annealing, and re-crystallisation phenomena, is briefer; but it suffices to indicate the type of applications in which the X-ray methods might be utilised with advantage. The inclusion of a chapter on electron diffraction is a valuable feature.

This first volume forms a complete text-book of the new science. It will also serve as a very readable guide to the more highly specialised sections to follow. Workers in allied sciences, chemistry, metallurgy, or engineering, will find it a full introduction to a tool which has already delved deeply into the intrinsic structure of materials.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

SEVEN CARDINAL FALLACIES.

SIR,—It is a singular but significant observation that whenever a professing economist writes for THE ENGINEER it is always under the shadow of anonymity. There is, of course, a good reason for this, because throughout a prolonged period of crisis in the particular sphere of human activity of which they claim to have expert knowledge, not a single expert economist has vindicated that claim. Economists are the most discredited professional body in the whole range of scientific pursuit; hence their adopted name is "Nemo."

Your current issue contains another article by an anonymous economist entitled "Seven Cardinal Fallacies." The ghostly contributor of this article to the *Economist*, while labouring under very great difficulties in maintaining contact with the quotation of "A. A. B." which he claims as his sole excuse and inspiration, has actually fulfilled a commission to write a criticism of social credit. This covert journalism is offensive, both in its form and object, but, above all, it is the impertinence of its logic which chiefly draws forth protest.

Let us consider these so-called fallacies and their rebuttal by this hidden oracle.

Fallacy 1.—The fallacy of the machines, viz., "that technological progress has been so rapid in recent years that the supply of goods exceeds the possibilities of consumption." The contradictions of Nemo are "that human wants are infinite," "every commodity (*sic*) or service creates demand as well as supply," "technological progress has been gradual," "that from the earliest times there has been a mitigation of scarcity." Having read all that, it is a remarkable fact that the supply of goods does *in fact* exceed the possibilities of consumption, and the words over-production and under-consumption are well understood as accurate descriptions of objective facts.

Fallacy 2.—That modern production has outrun effective demand. The unknown one concedes that the depression is caused by failure of consumers' purchasing power, but argues that this has merely happened; it is not an inherent defect of a system, for all money costs are ultimately consumers' incomes, and if all was spent then there will be no deficiency of purchasing power. Without going into the essential but abstruse facts of credit creation and cancellation by the banks, it is only necessary to point out that the logical conclusion to be drawn from the above is that all the wages, salaries, and dividends that were ever earned are still lying about somewhere waiting to be spent! "Nemo" adds a rider that in any case an increased quantity of goods produced will cause a fall in price, but not in real profits. According to this, any manufacturer starting out on a programme of production in January, 1934, for sale in January, 1935, is perfectly certain to make a profit, even though the selling price in 1935 has fallen below cost. (None of these economic experts seem to know what a cost is!)

Fallacy 3.—"That mechanical development has made a large percentage of the world's labour unwanted." This is a fallacy according to the anonymous graduate of the London Scohol of Economics, because "the workers of the world now have it in their power to work as much and consume more." The relevant statistics show that the volume of production is increasing, and the numbers of employed people diminishing in all fully industrialised countries. The power of consumption is purchasing power, which is a function of employment. How then can the diminishing number of employed exercise the greater power of purchase required by greater total production?

Fallacy 4.—This is described as the *status quo* fallacy, whatever that may signify. All that the hidden hand submits on this head is that it is wrong to consider expedients to maintain industry running somehow. Of course it is a well-recognised fact that all text-books of economics prefer that industries and human beings should die off to satisfy their theories, but the industrial machine is capable of performing its designed service if a favourable set of conditions is devised.

Fallacy 5.—This which is termed a bastard fallacy is the idea that the monetary units issued should correspond to the "real wealth" of the community. This may be a bastard, but our dark companion alone knows why it is a fallacy. What on earth is a money system for? The charge of fallacy, however, is laid on the supposed impossibility of establishing a relationship between £ s. d. and tons of coal or pints of milk. If that is true, well—there has never been any trade in this world. The monetary indices of pints of milk and tons of coal, &c., have their base in cost of production of milk and coal. The producer who has laid out money in producing commodities of any kind knows how much he must recover to make a profit. But, as I have said before, these brilliant economists do not know what a cost is, much less do they know of cost accountancy.

Fallacy 6.—"All men are consumers, but not all are producers." Since the secret contributor is the only person in the world who thinks this is a fallacy, he can keep it without dispute.

Fallacy 7.—"All men are producers, but not all men are consumers." As his addiction to economic theorising has led him to suppose that this piece of nonsense is worth discussing, his writings should have no place in an engineering journal.

In conclusion, I beg to submit that it should be made less easy for the propaganda of economic error to appear in any journal which is associated with the honorable and honest profession of engineering.

FRED. H. AUGER.

Liverpool, 15, February 10th.

SIR,—Having read with much interest the Leader in your issue of the 9th, under the title of "The Machine Age," I immediately turned to the article under the above heading, to which you directed attention. I must admit I suffered considerable disappointment on reading it, for, while I can agree with your ascribing "liveliness" to the author, I cannot but disagree with your suggestion that he discusses with "effectiveness," if by this term you imply lucidity.

My reason for writing you, however, is not to cavil at this anonymous writer's style, but to point to an error of fact, which, one can only assume, arises from a printer's error in the *Economist*, for I have referred to this journal and find that it appears there also. This error occurs in the third paragraph of the article which contains the following statement:—

"For it is obvious that, since all money costs are ultimately consumers' incomes, enough incomes are generated by the process of production itself to buy the commodities produced" . . . This surely should read:—"All consumers' incomes are ultimately money costs"; for the bulk of such incomes arises from wages and salaries, which are changed into costs after, and not before, they are distributed.

M. JACKLIN.

London, S.W.18, February 9th.

ALL-STEEL COACHES.

SIR,—I regret not having seen Mr. Devlin's reply to my previous letter before to-day, or I would have replied earlier. If I was unjust in imputing bias, I am very sorry, and withdraw and apologise.

But the position seemed to me to be this:—There was a Press campaign in favour of all-steel stock. Perhaps I over-estimate both the knowledge of the initiator of the campaign and the powers of observation of the public, but to me, at all events, that seemed to be clearly directed against the L.N.E.R. So far as I know, no one defends or builds all-timber stock now, and the L.N.E.R. are conspicuous as favouring composite construction. Such a campaign might affect very seriously the relative distribution of passengers as between the "Royal Scot" and "Flying Scotsman" services, for example. And this did and still does seem to me to be grossly unfair in view of what one might call the "collision performance" of the stock supposedly under criticism.

I think it is at all events clear that there is a good case in favour of composite stock. In addition to what has already been said, there is one point which I do not think has been mentioned, viz., side doors. A good authority has said that it is difficult to provide ordinary English compartment stock with numerous side doors in "all-steel." That surely is strongly against it. Could such remarkable platform times as those which I have timed over and over again at Leicester Central, where heavily loaded expresses are away in under 2 min., be achieved with end doors only? Rapidity and ease of ingress and egress are important in collisions! It is noticeable that the corresponding L.M.S. trains with open saloon coaches often overstay their 4 min.

On the other hand, it is equally clear that there is no case whatever for gas cooking. It was Mr. Devlin's light dismissal of gas as "rapidly becoming obsolete" which "set me off." That dining cars form only a small portion of our trains is, I take it, not meant as a defence. It would be small consolation to the unfortunate occupants of the dining car to know that they were only a minority in being fired to death in a steel box from which they could only be extricated with great difficulty! After all, the amount of gas must be large, and there must be naked flames burning during most of the journey.

If there is a practice for criticism, then surely it is that of building seventy "Royal Scots" and 190 Midland compounds after amalgamations, neither of which types, apparently, is inclined to provide the extra power required to drive a cooking dynamo. (Thank you, "L. A. F.") It is interesting, and perhaps fortunate for our reputation that the "Royal Scot," when on tour, had all-electric cooking. But her load was only 268 tons.

No, Sir, it still seems to me that there is a better case for compelling the general adoption of L.N.E.R. practice than *vice versâ*.

H. M. LACEY.

Leicester, February 10th.

MEASUREMENT OF INACCESSIBLE CLEARANCES.

SIR,—We are wanting to use a very soft metal wire which we would propose to squeeze between two inaccessible conical surfaces, where we desire to check clearances.

At present we have been using fuse wire for this purpose, but we find that it is not quite soft enough, and also that it possesses a certain amount of spring, so that its micrometer thickness varies according to the length of time elapsing between its having been squeezed and its measurement being taken. The clearances in question vary between 0·003in. and 0·015in.

We shall be glad if any of your readers can assist us towards obtaining a suitable material for this purpose.

F. W. BRACKETT AND CO., LTD.

Colchester, January, 12th.

THE IDEAL LOCOMOTIVE.

SIR,—I have just been reading the letter in your current issue on locomotive design, and am reminded of what a C.M.E. I once knew used to say to his designers: "The ideal locomotive has one wheel, one cylinder, and uses steam at a thousand degrees. You will not be able to follow this in the design I am asking for, but get as near as possible."

February 10th. S. MOUN.

THE INSTITUTE OF METALS.

THE annual general meeting of the Institute of Metals will be held at the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1, on Wednesday and Thursday, March 7th and 8th, 1934. On Wednesday, March 7th, at 10 a.m., the general meeting will be held and the President, Dr. H. Moore, will deliver his address. The following papers will then be presented for discussion: "Minimum Dimensions of Test Samples for Brinell and Diamond Pyramid Hardness Test," Dr. G. A. Hankins and Mr. C. E. Aldous; "Note on the Influence of Gases in an 8 Per Cent. Copper-aluminium Alloy on Normal and Inverse Segregation," Dr. I. G. Slater; "Diffusion of Zinc and Iron at Temperatures Below the Melting Point of Zinc," Mr. G. Rigg. At 2 p.m. the meeting will be resumed and further papers will be discussed:—"Influence of the Intercrystalline Boundary on Fatigue Characteristics," Dr. H. J. Gough, Mr. B. L. Cox, and Mr. D. G. Sopwith; "The Viscous Properties of Extruded Eutectic Alloys of Lead-tin and Bismuth-tin," Mr. C. E. Pearson; "A Note on some Formulæ Concerning Viscous and Plastic Flow in Soft Metals," Dr.-Ing. E. W. Fell; "Castability of Ternary Alloys," Professor A. Portevin and Dr. P. Bastien. The annual dinner and dance will be held on that evening at the Trocadero Restaurant. On Thursday morning the meeting will start at 10 a.m. and the following papers will be discussed:—"Alloys of Silver and Beryllium," Mr. H. A. Sloman; "Transverse Tests on Sand-cast Aluminium Bars," Mr. C. E. Phillips and Mr. J. D. Grogan; "The Constitution of Copper-iron-silicon Alloys," Professor D. Hanson and Dr. E. G. West; "Transformations in the Copper-palladium Alloys," Mr. R. Taylor. The following papers will be formally presented, but not discussed:—"The Malleability of Nickel and Monel Metal," Mr. O. W. Ellis; "The Constitution of the Alloys of Magnesium in Nickel," Dr. J. L. Haughton and Mr. R. J. M. Payne. At 2.30 p.m. the delegates to the meeting will visit the Post Office Engineering Research Station, Dollis Hill, London, N.W.2, leaving St. Ermin's at 2 p.m.

The Chloramine Process.

ALTHOUGH the Metropolis is, admittedly, the best served of all cities in the way of potable water, we believe that it was another London, in Ontario, that first felt the benefits of the use of chlorine gas as a means of ensuring that the water in the mains was free from bacteria, although chlorine had been used previously in the form of bleaching powder at Maidstone and Lincoln, while in Germany bromine had been used as early as 1870. But now the chlorination of water supplies is fairly common, not only for domestic services, but also for industrial purposes, such as condenser cooling water, where the treatment will prevent algal growths in the tubes and cooling towers.

The original manner of effecting addition of chlorine was by the application of a solution of bleaching powder, but this has been completely displaced by the much more precise and efficient system of gaseous chlorination using pure liquid chlorine. The liquid evaporates at ordinary temperatures, and the gas is conveniently controlled by suitable apparatus.

One of the first instances of routine chlorine sterilisation in this country (using at that time the bleaching powder method) was the installation in the Paterson rapid gravity filtration works at Tewkesbury for the Cheltenham Corporation, purifying river Severn water for distribution as a drinking supply. This plant is now being doubled in capacity and the old bleach plant replaced by modern ammonia chlorine apparatus employing the process dealt with in this article.

Chlorine and chlorine compounds have a marked superiority over other sterilising agents in that they are easily applied, rapid in action, and inexpensive. In practice it is found that, in addition to the bactericidal action, there is also an oxidising effect, which increases the amount of chlorine required for disinfection, and in some instances the oxidised compounds give rise to taste troubles. As far back as 1900 the use of ammonia in conjunction with chlorine had been proposed, and although it was ten to twelve years later before any attempt was made to use this process on a practical scale, the work of Raschig, Rideal, Race, Houston, Adams, Hale, and Harold, gave sufficient evidence that the process had in certain cases advantages over plain chlorination. It has been suggested by some investigators that the bacterial cell may act as a colloid, and that the ammonia is absorbed on the surface of the cell, so weakening the protective coating and permitting chloramine to come into intimate contact with the organism. In any case, little or no doubt exists that the ammonia-chlorine method (or chloramine process, as it is commonly called) can be credited with :—

(*a*) The prevention of tastes due to oxidation and chlorinated compounds formed by the interaction of the chlorine and the impurities in the water.

(*b*) Reduction of the chlorine requirements of drinking waters, swimming pool contents, and supplies used for paper manufacture and other purposes.

(*c*) The maintenance of active sterilant in the treated waters for prolonged periods, thereby reducing algal and preventing bacterial after-growths.

(*d*) Ability to allow a higher residual chlorine without giving rise to taste.

The process is very simple to apply, and requires the accurate addition and thorough mixing of ammonia either as gas or as a solution of an ammonium salt, to the water, followed by chlorine and further mixing. The ammonia dose naturally varies according to the type of water, but can usually be regarded as about one-quarter of the chlorine dose. The cost of treatment is low, and the amount of apparatus small ; a point of importance is that an existing chlorination process can be readily and cheaply converted to the chloramine process.

The combined ammonia and chlorine system is of a special value in small plants, since it permits a latitude in chlorine dosage without danger of taste production and permits easy treatment of waters of variable organic and bacterial contents to be disinfected without incurring appreciable alteration in the supervision required.

The advantages accruing from the use of a minute dose of ammonia (amounting usually to no more than 0·2 parts per million), in conjunction with chlorine addition, may be summed up as :—

(*a*) An increased overall efficiency of the sterilising process.

(*b*) A reduced consumption of chlorine.

(*c*) Satisfactory bacteriological purification in spite of variation in quality of raw water.

(*d*) Prevention of taste troubles.

The Paterson Engineering Company, Ltd., of Windsor House, Kingsway, London, has been responsible for a good deal of research work on this aspect of water treatment, and has carried through the installation of many plants in Great Britain and overseas embodying this process of effecting sterilisation. In every case the addition of the chlorine is effected by means of the chloronome, of which we gave a description in our issue of November 17th, 1933.

For dealing with supplies exceeding, say, a million gallons a day, the Manometer Chloronome measures the flow of chlorine by the difference in pressure on either side of the orifice. The chlorine gas is led through the connector valve and flexible copper coil tubes, which are unaffected by the gas so long as it is dry, to the control board. In the case of large installations, the cylinders or "bottles" of chlorine are arranged in groups, and connected through headers with a chlorine gas main. After passing a filter, the chlorine flows through the two pressure-reducing valves, and is delivered at a constant pressure of 10 lb. per square inch. From the regulating valves the chlorine passes through a fitting containing a silver diaphragm plate, having an orifice of predetermined size.

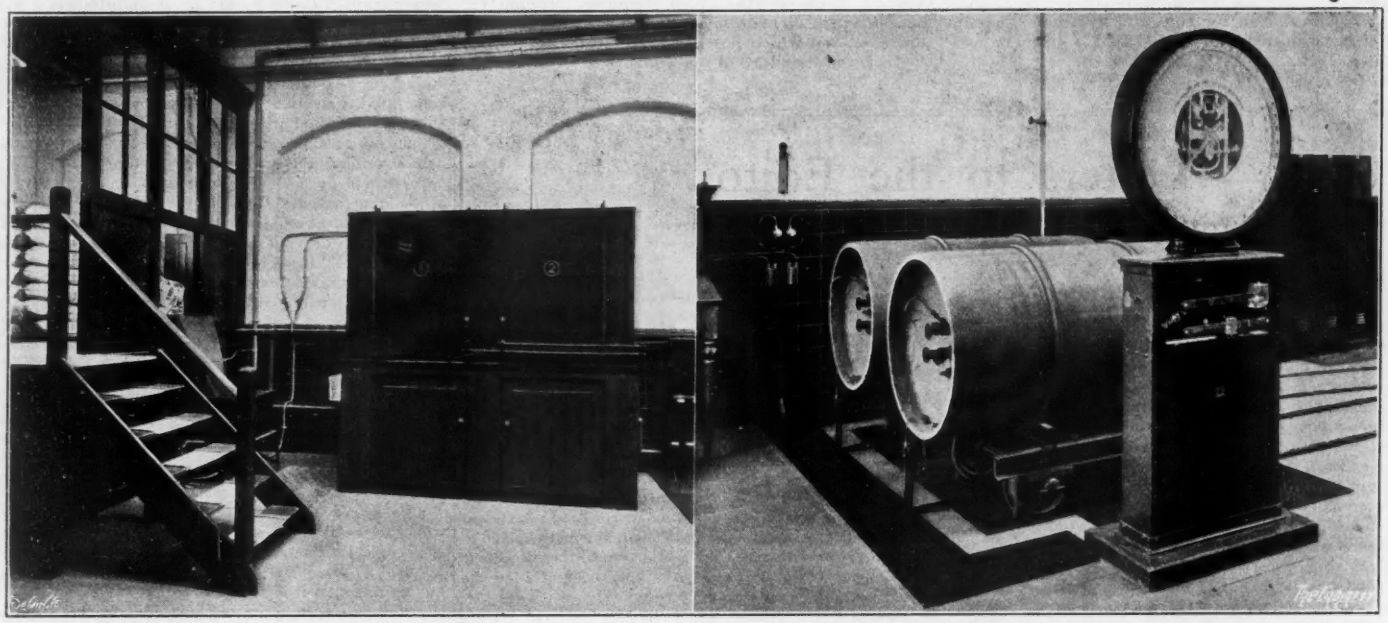


FIG. 1—STORAGE TANKS AND DOSING EQUIPMENT

FIG. 2—CHLORINE DRUMS AND WEIGHING MACHINE

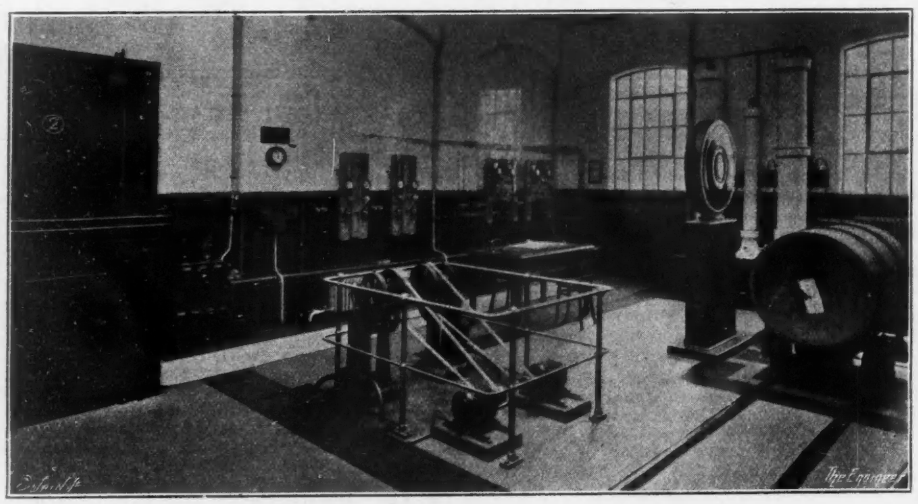


FIG. 3—GENERAL VIEW OF AMMONIA AND CHLORINE PLANT

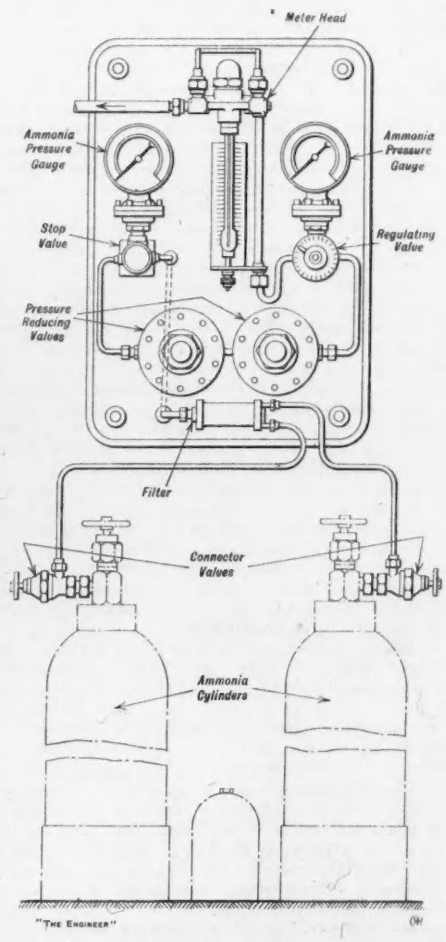


FIG. 4—CHLORONOME

A connection from either side of the diaphragm is led to the two limbs of a manometer tube, and the difference of pressure set up by the rate of flow of the gas causes a displacement of the liquid contained in this tube. The height of the liquid column indicates on a graduated scale the exact flow of gas in pounds of kilogrammes per hour. Each scale of this meter is calibrated in conjunction with the orifice with which it is to work, so as to ensure the utmost degree of accuracy.

The manometer tube is provided with a safety trap on one limb which makes it impossible for the liquid column to be blown out of the tube by careless or inadvertent manipulation. This is of importance, because the ejection of the liquid into the mechanism would not only put the instrument out of action, but might entail partial dismantling for cleaning purposes.

The gas, after passing through the orifice, is conducted through chlorine-resisting tubing to a moisture seal containing a liquid inert to chlorine, such as sulphuric acid, through which it bubbles, and is then led to an absorption tower. The glazed earthenware absorption tower is fitted at the top with a water distributing tray, and is packed with pumice. A small trickle of water is uniformly distributed over the pumice, and in its downward flow absorbs the measured quantity of chlorine gas as it ascends in the tower. The chlorine solution so formed flows from the bottom of the tower through a chlorine-resisting rubber or earthenware pipe, and is injected into the main volume of water to be disinfected.

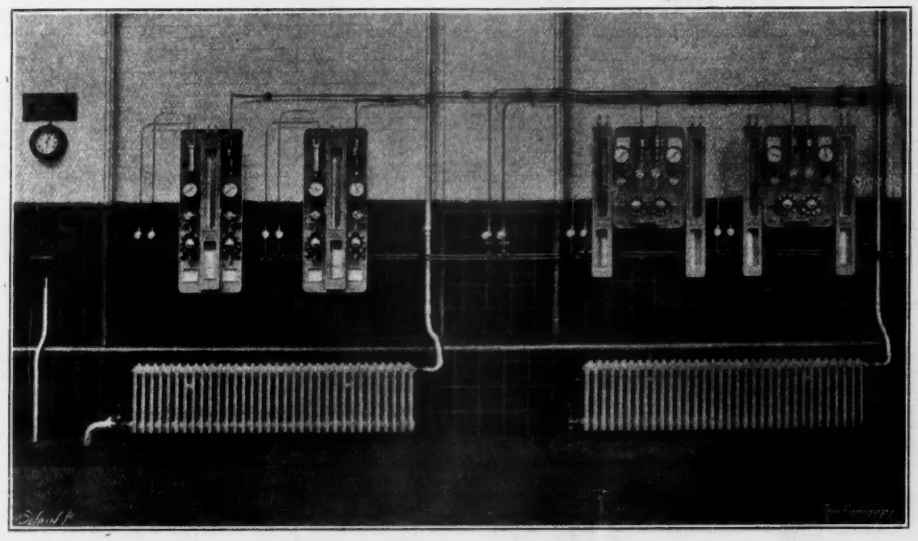


FIG. 5—PATERSON CHLORONOMES

THE PROCESS AT HAMPTON.

At a number of the works of the Metropolitan Water Board (where in some cases the chlorination process had already been in operation for several years), the Paterson Engineering Company has installed the additional equipment necessary for applying the combined ammonia and chlorine, *i.e.*, chloramine process, and we reproduce some photographs and the general lay-out of the apparatus at the Board's Hampton works herewith.

It should be explained forthwith that the plant was installed in an existing building, which was made available in consequence of the modernisation of the main pumps and that its spacious appearance is not really necessary for its satisfactory working.

The ammonia required for the "dosage" of the water is supplied in the form of the sulphate, a cheap and readily procurable commodity, which is kept in the store seen on the left of Figs. 1 and 6. It is dumped, as required, through the hatchway behind the stairs into a hopper, and is delivered by a water injector into either of the two tanks, which show so prominently in the engraving.

Each of these tanks contain sufficient concentrated solution of sulphate of ammonia for one day's run. The solution is decanted from the working tank into the little cistern seen on the right, near the top of the dado. From this cistern the solution drops into the distribution tank below, for this installation has to provide sterilisation for four different supplies of water, aggregating some 50 million gallons per day.

The outlet from the cistern is regulated by a needle valve, which is fitted with a graduated micrometer dial, so that the rate of flow may be accurately controlled. There is a check on the calibration of this valve in the form of a calibrated funnel, through which the solution falls. If the lower end of the funnel is closed, the rate of flow can be checked with the aid of a stop watch.

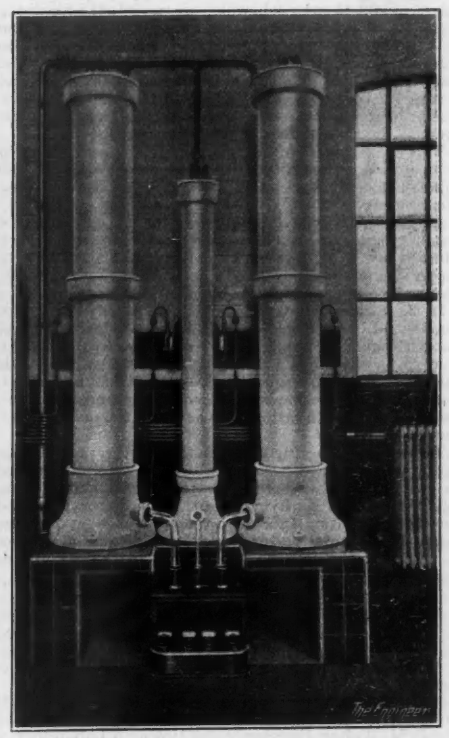


FIG. 7—ABSORPTION TOWERS

In this distribution tank the strong solution is diluted, to make quantities more accurately measurable, and it is then apportioned to the several supplies through a further set of micrometer needle valves. The setting of these valves is determined by the amount of water pumped. The solution is piped to the suction side of the various main pumps, but as, in the case of one of the pumps at Hampton, the suction is sometimes under a positive head, a small belt-driven pump, seen in Fig. 3, is provided to force in the solution.

The chlorine apparatus is of the Chloronome type just

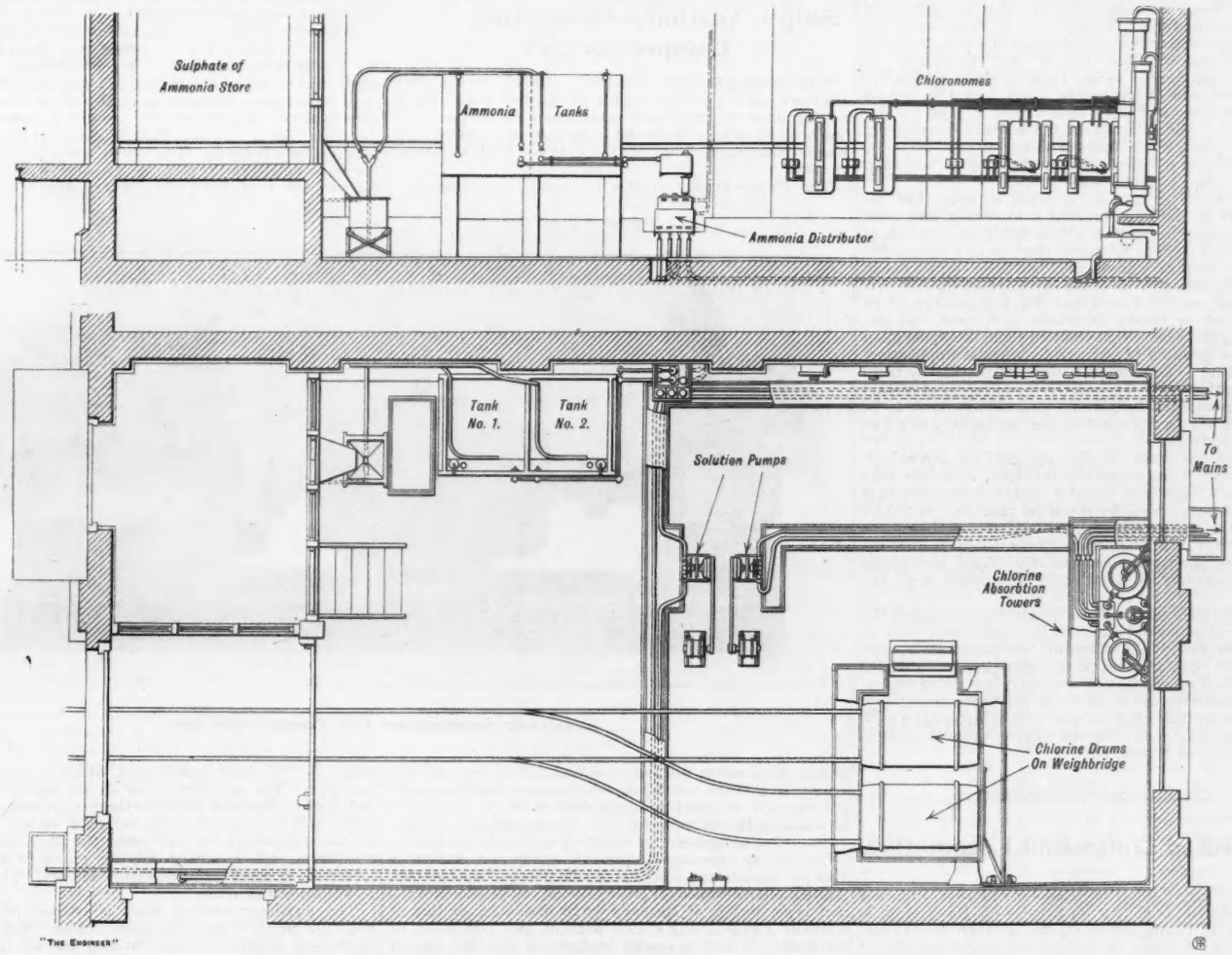


FIG. 6—GENERAL LAY-OUT OF PLANT AT HAMPTON WATER WORKS

described, and can be seen on the wall in the background of Fig. 3. The "panels" are of grey enamelled cast iron, and look very neat with the names of their supplies cast in and the pipework of highly polished copper. It is noteworthy in this connection that in spite of all the joints in the chlorine piping, we could not detect the faintest odour or tarnishing and corrosion in the treatment house.

The liquid chlorine is delivered in large steel drums containing about 15 cwt. each, which are run into the sterilising house on trolleys. These trolleys are put on the platform of a weighbridge—see Fig. 2—and connected with the chlorine mains by means of flexible copper pipes. The dial of the weighbridge is graduated in 7 lb. divisions, and is very sensitive. By calculating from the reduction in the weight of the drums as the chlorine is used up, a check is provided on the readings of the Chloronome meters.

This same system of applying the ammonia sulphate is in operation at many other waterworks throughout the country, including those at Bath, Reading, Chester, and West Surrey.

An alternative method of effecting the sterilising of drinking water by the chloramine process, which has been adopted by a number of authorities in England, is to supply the ammonia in gaseous form, retaining the subsequent chlorine apparatus, as already described.

In these cases where the ammonia is readily obtainable compressed in steel bottles, the gas is introduced into the water through an apparatus, very similar to the Chloronome, which is shown in Fig. 4. The gas from the bottle passes through two reducing valves at the inlet and outlet, from which its pressure is indicated on appropriate gauges, and then through a manometer meter to the point of consumption.

There is yet one further variation of the process that might be mentioned, which has been successfully applied to swimming baths where the water is continuously circulated through a purifying plant. The water is passed through a Venturi tube and the difference in pressure between the throat and the inlet is used to induce a flow of ammoniacal solution in proportion to the rate of the main flow.

Gas as Petrol Substitute.

SOME interesting figures relating to the use of gas instead of petrol for commercial vehicles were quoted by Dr. C. M. Walter, Director of the Research Laboratory of the Birmingham Gas Department, in a lecture on February 1st before the Bristol Section of the Society of Chemical Industry on "The Industrial Applications of Town's Gas." From statistical information available, he said, it appeared that for the operation of petrol-driven vehicles used in connection with transport of passengers and goods by some of the larger undertakings such as the transport companies and railway companies, about 100 million gallons of petrol were used annually. If that amount of fuel were replaced by town's gas it would result in an additional quantity of no less than 25,000,000,000 cubic feet of gas being manufactured, for the production of which approximately 1,700,000 tons of coal would be required to be carbonised, resulting in the production of rather more than a million tons of coke. In addition to that, vehicle equipment to the value of about £2,000,000 would require to be manufactured, which would include no less than 4700 tons of alloy steel vehicle bottles for the storage of gas. And about £4,000,000 worth of compressing and storage plant, with motors or steam engines, would be required, the storage plant alone calling for no less than 17,000 tons of alloy steel storage bottles.

It was interesting to note, said the lecturer, that the greater part of the experimental work which had been done, particularly in regard to the modification of standard types of petrol engines to enable them to give reasonable performance on town's gas as fuel, had been carried out in the Research Laboratories of the Birmingham Gas Department. There was still a good deal of experimental work to be carried out in regard to vehicle equipment and gas compressing plant before gas traction could be looked upon as a scheme possible of general commercial application. The difficulties to be overcome were not necessarily technical, but rather centred round the modification of certain existing regulations which would undoubtedly have to be made before town's gas could be used universally as a fuel in place of liquid fuel.

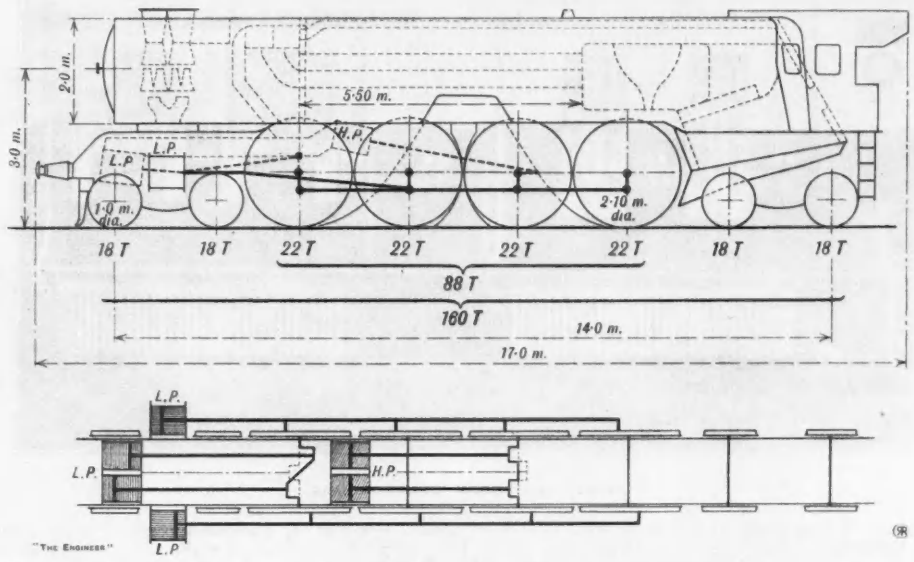
The economics of the use of compressed gas as a substitute for petrol were somewhat involved, in so far that under present conditions, whilst it could not be stated that all types of heavy vehicles could be operated on town's gas at a lower cost than petrol, it would appear that in the case of fleets of vehicles operating over distances upwards of 100 miles per day, a considerable saving in running costs could be obtained if gas could be supplied at 4d. per therm.

Dr. Walter also spoke of the enormous increase in the use of gas for industrial purposes that had taken place in Birmingham and other industrial centres where special facilities had been afforded to manufacturers with regard to the method of application and carrying out of experiments to ensure the use of gas in the most economical way. The present annual output of gas in Birmingham, he said, for purposes other than domestic was ten times the output in the year ended March, 1911.

A Projected Compound Locomotive.

IN the January number of *Science et Industrie*, Monsieur André Chapelon, Ingénieur au Service du Matériel de la Compagnie d'Orleans, submits a design, reproduced herewith, for a six-cylinder compound locomotive capable of hauling 600 tons at 170 kiloms. per hour on the level and at 140 km.p.h. on a gradient of 5/1000; or 1000 tons at 150 km.p.h. on the level and 120 km.p.h. on a similar gradient.

Monsieur Chapelon is in no doubt about the future development of the compound. If, he says, there is difficulty in placing still larger low-pressure cylinders between the frames, there is no reason why, following the example of the P.L.M., they should not be put outside with the H.P. cylinders inside, each group operating separate coupled axles. By pursuing this plan he regards 4000 to 5000 H.P. as attainable, since the only limit is the maximum load which a crank axle can bear. But if the load on one axle becomes too great, then it is only necessary to add another axle with its appropriate cylinders. Hence the compound of the future may take the form indicated in the sketch. It will have a driving crank axle for the two H.P. cylinders, a crank axle for one pair of L.P. cylinders, and crank pins for the other pair of L.P. cylinders. The horse-power attainable will easily be 2000 on each axle, or 6000 in all with cylinders of moderate dimensions. The wheels will be 2100 m. (82½ in.) diameter. In this project there is nothing, he says, outside ordinary experience and no part is subjected to unknown stresses.



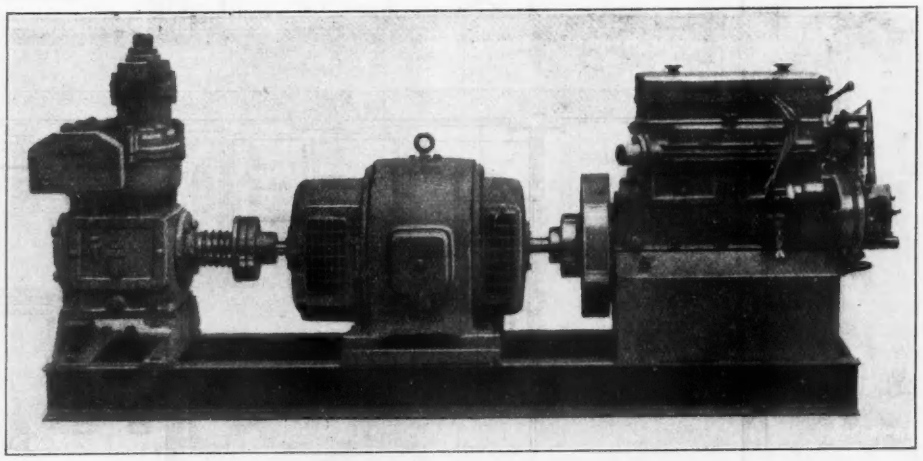
PROJECTED COMPOUND LOCOMOTIVE

The H.P. cylinders of the engine shown in the sketch are 510×670 mm. and the four L.P. cylinders each 570×670 mm.; the boiler pressure is 320 lb. per square inch, and the steam temperature 450 deg. Cent.

Ship's Auxiliary Generating and Compressor Set.

THE accompanying illustration shows a standard auxiliary set for yachts, motor ships, and other vessels relying upon electrical and compressed air services. It has been recently put on the market by the Parsons Oil Engine Company, Ltd., of Town Quay Works, Southampton.

The engine is one of the Parsons "Ten-Twenties" series, designed to use kerosene fuel and to run at 1000 r.p.m. It is direct coupled to a compound-wound generator giving 5 kW at 1000 r.p.m., the shaft of which is extended as shown at the commutator end. From that point a high-pressure air compressor for charging bottles, &c., is driven, which has an approximate piston displacement of 22 cubic feet per minute and delivers air at 450 lb. per square inch. The coupling between the generator and compressor is of the pin type, but is of specially large diameter, so that it actually forms a dog clutch without any possibility of backlash. It will be readily understood that the sizes of the generator and the air compressor may be varied, and to meet these requirements many different types of generators for different voltages and compressors of differing capacities can be supplied according to the owners' requirements. So far as the engine is concerned, its manufacture and its component parts are made in excess of the Board of Trade and Lloyd's Register requirements.



AUXILIARY GENERATING AND COMPRESSOR SET

Cold Roll Mill Drive and Barring Gear.

THREE sets of cold roll mill drives and barring gears of interesting construction have recently been supplied by Craven Brothers (Manchester), Ltd., Reddish, Stockport, for a well-known tin-plate works in South Wales. The set illustrated on the next page is intended for driving five mills in line by means of a 150 horse-power electric motor. The other two are for operating four mills each by means of 125 H.P. motors.

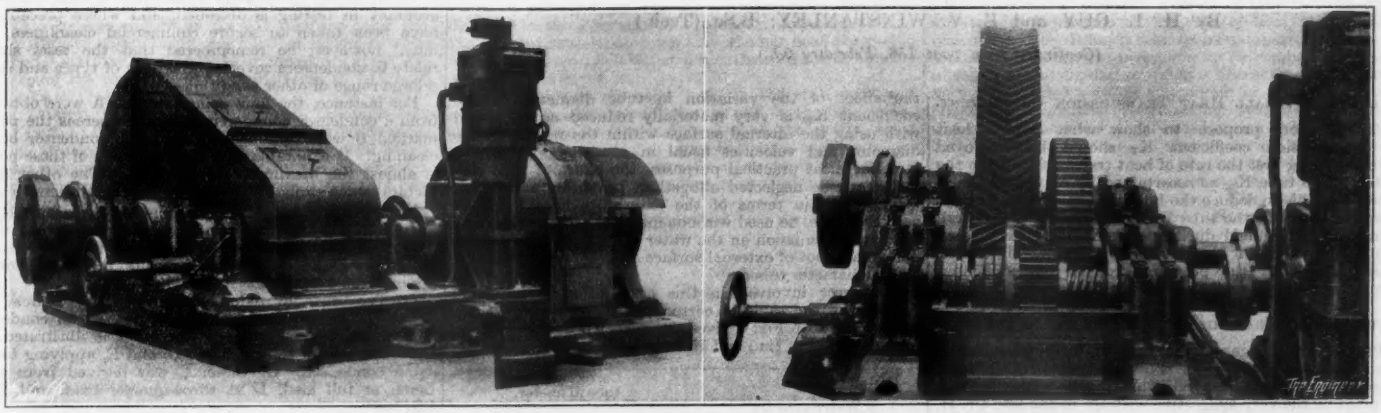
The drive is first started by means of the barring motor, and when the main motor takes up the load, the barring gear is automatically thrown out of action. The main drive is taken by a pair of double helical gears, the pinion of which is of forged steel solid with the shaft. The large wheel consists of a forged steel ring carried on a cast steel centre with a powerful flexible coupling for connecting up to the first of the mills. The gearing is carried on shafts running in self-oiling bearings mounted on a large cast iron base plate. The auxiliary drive for barring purposes is by means of a 15 H.P. vertical flange-mounted motor through a worm reduction gear-box and a single steel spur gear to the main driving motor shaft extension.

The worm gear-box is a separate unit made in halves, the motor being mounted on top of the unit, while the worm and worm shaft are made in one piece from 3 per cent. nickel case-hardening steel, the worm threads being case-hardened and afterwards ground to correct shape At both ends the worm shaft is mounted in a double-purpose ball bearing. The worm wheel is of phosphor bronze, centrifugally cast to produce a homogeneous mixture free from flaws and defects. It is mounted on a shaft of 40/45 tons tensile steel, which is carried in ball bearings. The worm runs in an oil bath. A flexible coupling is provided between the output and the pinion shaft, and the spur pinion is mounted on a screw shown in one illustration, so that when the main motor starts the drive, the auxiliary driving pinion automatically slides out of mesh with its wheel, and the 15 H.P. motor is tripped out of action.

The auxiliary driving shaft is carried in self-oiling bearings on the main base plate frame, while the main motor and auxiliary worm reduction unit are mounted on a common base plate attached to the main frame. All bearings have gun-metal bushes. With a main motor speed of 375 revolutions per minute, the gear will reduce the revolutions of the final output shaft to 48 revolutions per minute.

The barring gear is arranged so that it can be used for turning the rolls in position in the mill at a speed of 1½ revolutions per minute. Inch reverse is incorporated in

the barring gear to facilitate the removal of couplings between the rolls, and interlocks are fitted to avoid incorrect operation and to provide for the automatic stopping of the barring motor when the main motor is put into operation. Safety indicating devices, including lamps, ammeters, and isolating switches are provided



150 H.P. COLD ROLL MILL DRIVING GEAR

Foreign Chemical Engineering Plant.

SOME interesting comments were made concerning the use, under the conditions in this country, of chemical engineering plant designed and constructed abroad, at a joint meeting of the Institution of Chemical Engineers and the London Section of the Society of Chemical Industry at Burlington House, London, on Monday, January 8th.

The occasion was the discussion on a paper by Mr. J. Davidson Pratt (of the Association of British Chemical Manufacturers), and Mr. G. S. W. Marlow, entitled "Legal Pitfalls for the Chemical Engineer." The paper was a review of legislation as it applies to chemical manufacturing works, and it, of course, included legislation which applies also generally to industry. One section of the paper was devoted to steam boilers, and in a discussion of the penalties which can be imposed upon the designer and constructor of a boiler in the event of an explosion—or the person responsible for its maintenance and its use—it was pointed out that these penalties cannot at all easily be recovered when the boiler is of foreign origin, unless the foreign manufacturer has property within the jurisdiction which can be sequestrated to satisfy the judgment. It was pointed out that there is no ready means whereby in all cases the British buyer can assure himself as to this, and the authors expressed the view that we have here an insidious form of trade competition, in that the foreign builder of boilers may use a lower factor of safety and take a greater risk than the British maker, as he knows that no financial liability can fall on him in the event of an explosion, so long as he maintains no stocks or monies in Great Britain.

In the discussion, Mr. J. Arthur Reavell said there had been serious competition in this country from plants built abroad to regulations which would not hold in this country, and, unfortunately, such plants were insured by the English insurance companies. He suggested that efforts should be made to get the help of the insurance companies to try and stop this form of competition. Quite recently, he said, he had had to investigate an explosion in a plant built on the Continent, and used here, and it had actually failed at half its working pressure, although it was supposed to have been tested at twice that pressure.

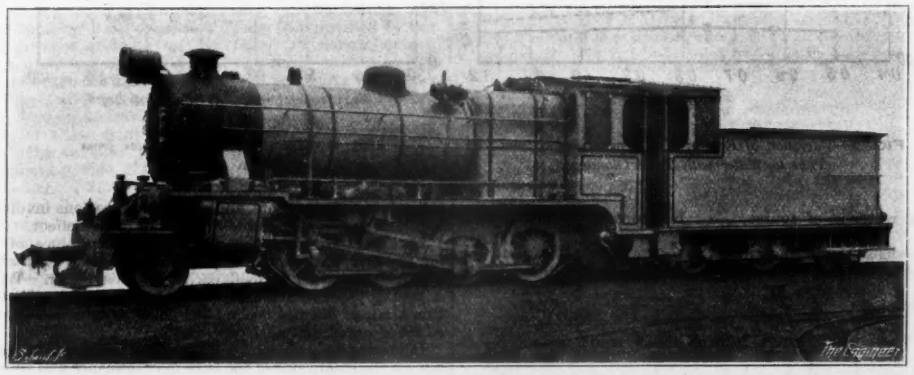
Mr. H. Griffiths also commented on this matter, but suggested it was not altogether satisfactory to imply that because plant was manufactured in a foreign country it was necessarily weaker or cheaper than plant manufactured here. In this country we were dependent on what were known as the Board of Trade rules, which were very often quoted, but very seldom read. A glance at the original rules, however, showed that they were based on the regulations for steam boilers on passenger ships; they were not very embracing, and they covered only a very limited range of chemical engineering problems, and thus were not very satisfactory for chemical plant design. It often happened, indeed, that manufacturers in this country, in order to design particular plant, had to consult the German Boiler Code or the American Boiler Code, or even the Non-Fired Pressure Vessel Code, which was a very good code for some types of chemical plant. The unwary might land themselves in serious trouble in purchasing plant from abroad and, therefore, when doing so, it was best to specify that it should satisfy the rules of the English insurance companies. This would be found to give adequate protection to all parties.

Mr. J. Davidson Pratt, replying on this point, said there had been no intention in the paper to reflect on foreign manufacturers. The word "may" was used, and he quite agreed that many foreign firms did not use the method of competition referred to. At the same time, a number of cases had occurred, but the suggestion made by Mr. Griffiths for overcoming the difficulty seemed to be a very good one.

The paper was regarded as such a valuable review of the legislation applying in particular to the chemical industry, that more than one speaker expressed the hope that it would be made available generally to those interested, and we are asked to state that copies of the paper are available at the offices of the Institution, Abbey House, Victoria-street, S.W.1, at the price of 3s. each.

Udaipur Chitorgarh Railway.

THE engraving below shows one of three 2–8–0 type tender locomotives just designed and built by W. G. Bagnall, Ltd., Castle Engine Works, Stafford, for the Udaipur Chitorgarh Railway. The principal dimensions of the locomotives are as follows :—



2-8-0 LOCOMOTIVE FOR INDIA

Engine.

Cylinders	16½ dia. by 22in. stroke
Coupled wheels, diameter	3ft. 7in.
Leading bogie wheel diameter	2ft. 6in.
Fixed wheel base	12ft. 6in.
Total wheel base, engine	19ft. 11in.
Heating surface : Tubes	888 square feet
" " Superheater	175 "
" " Fire-box	100 "
" " Total	1163 "
Grate area	25·5 "

Tender.

Water capacity	2500 gallons
Coal capacity	4½ tons
Wheels, diameter	2ft. 4½in.
Total wheel base	11ft.
Total wheel base, E. and T.	42ft. 1½in.
Weight of engine and tender—	
Empty	51·6 tons
In working order	71·1 tons
Tractive effort of locomotive at 85 per cent. B.P.	21,980 lb.

These three locomotives are fitted with specially large boiler and fire-box, which ensures an ample supply of steam under all conditions. The fire-box is of the wide type, having straight sides over the top of the frame. The ash-pan is of the self-dumping type, and the fire grate of the rocking type with drop grate. The rocking and drop grates are operated from the cab footplate, each by a separate lever, but the ashpan dumping door is situated outside the cab, so that it cannot be opened whilst the locomotive is in motion. The wheels are compensated in two groups, the leading truck with the first and second pair of coupled wheels, and the driving and trailing pair in another group. The smoke-box is carried on a heavy saddle. Among the fittings of the locomotive are included a "Sunbeam" electric light, "Ross" pop safety valves, "Everlasting" blow-off cocks, Gresham and Craven Super Dreadnought ejector with combined steam brake valve, A.B.C. couplers, top feed clack-box, piston valves, &c., and the boiler is clothed with asbestos mattresses. In the design especial attention has been given to accessibility and maintenance. The cab is roomy and provides an excellent look-out for the driver.

The locomotives are for use on the Ghat (Hill) section of the railway, where gradients of 1 in 50 have to be climbed.

W. G. Bagnall, Ltd., sent out at the beginning of this year to the Gaekwar's Baroda State Railway, India, six locomotives of a similar type and design, but of the 4–6–0 type, and with a slightly lighter axle load.

SIXTY YEARS AGO.

UNDER the Merchant Shipping Act of 1854 steamships were required to be provided with a safety valve on each boiler. The valve, it was specified, was to be out of the control of the engineer when steam was up. It was further laid down that if the required valve were in addition to the ordinary safety valve, its area should not be less and its pressure not greater than the area and pressure of the ordinary valve. Nothing whatever was said concerning the type of valve that was to be provided. The Act was still in force twenty years later, but the manner in which this clause dealing with the provision of safety valves was being interpreted by the then Chief Surveyor to the Board of Trade, Mr. Macfarlane Gray, was a cause of much criticism and discontent among shipowners and marine engineers. Gray was devoted to the deadweight safety valve, and in the face of almost unanimous opinion in favour of spring-loaded valves—including the opinion of many of his own staff of surveyors—he issued instructions which had the effect of making it impossible for the surveyors to pass spring-loaded valves. Latterly, he relaxed that rule sufficiently to allow the use of spring-loaded valves experimentally, but the conditions which he simultaneously imposed were of a vexatious character. In our issue of February 13th, 1874, we reprinted a paper "On the Advantages of Springs for Loading Government Safety Valves of Marine Boilers Instead of Dead Weight," which Mr. H. R. Robson had read before a recent meeting of the Institution of Engineers and Shipbuilders in Scotland. In a leading article in the same issue we gave strong support to Mr. Robson's arguments. Gray's main objection to the spring-loaded valve was that as the valve rose the force exerted by the spring to close it increased, and therefore that before the valve could rise sufficiently to relieve the boiler, the pressure of the steam had to increase considerably beyond the value at which blowing off began. We admitted that in the days of the old "box" boiler, working at 20 lb., a rise of 5 lb. might be required before a spring-loaded valve could blow off enough steam to afford relief, and that such rise might do serious injury. But in these days of high pressure, with boilers working at 60 lb. and capable of withstanding up to 180 lb., a rise of 5 lb. could not possibly involve danger. In any event, we continued, it was quite possible to design a spring-loaded safety valve in such a way that it would fulfil its function with a rise in pressure of not more than 1 lb. That was a figure which a deadweight valve could not surpass or even equal. Against the deadweight valve there was the strong objection that in rough weather the inertia of the weight caused it constantly to blow and waste steam. The position of the Board of Trade on this subject was, we argued, thoroughly inconsistent, for while its marine surveyors insisted or were made by Macfarlane Gray to insist upon the use of deadweight valves, its officers entrusted with the care of our railways were perfectly content with spring-loaded valves on locomotives. We urged that a united movement should be made by marine engine builders and shipowners to get rid for ever of the deadweight valve. To that end we recommended that in the next session of Parliament the terms of the Merchant Shipping Act should be changed to prevent any single individual from over-ruling the opinion of the engineering public at large.

The Design of Surface Condensing Plant*

No. II.

By H. L. GUY and E. V. WINSTANLEY, B.Sc. (Tech.)

(*Continued from page 156, February 9th.*)

VALUE OF OVERALL HEAT TRANSMISSION COEFFICIENT.

THE authors propose to show what overall heat transmission coefficient K_T should be employed by considering first the rate of heat transmission from the water to the tube K_W as ascertained by experiment, and then using this to deduce the heat transmission coefficient from the steam to the tube K_S by analysis of the overall transmission obtained during tests in actual condensers, using the value of the mean temperature difference, which allows for the pressure drop in the condenser, as suggested in the preceding section.

RATE OF HEAT TRANSMISSION FROM WATER TO TUBE K_W.

Precise knowledge of the rate of heat transmission from the tube to the water is available as a result of the very comprehensive research which, in its inception, was inspired by the very suggestive writings of the late Mr. H. M. Martin. This research was carried out by the British Electrical and Allied Industries Research Association, and which was published in the "Proceedings" of the Institution ("Proc.," Vol. II., 1930), and the Royal Society, in able and important papers presented by the investigators, Mr. A. Eagle and Mr. R. M. Ferguson.

The experimental results of this research, so far as they relate to the heat transmission coefficient K_W from a ¾in. outside diameter 18 S.W.G. tube to water, and co-ordinated by the theory which Messrs. Eagle and Ferguson developed, were presented in Fig. 2 of their paper before the Institution of Mechanical Engineers for a range of heat flow of from 0 to 20,000 B.Th.U. per square foot per hour, and for various water velocities and temperatures.

These results can be more readily used by engineers interested in condensing plant when presented in terms of the external diameter of the tube instead of the internal surface which formed the basis of Eagle and Ferguson's Fig. 2.

Such a rearrangement is given in Fig. 4 for the range of mean water temperature and water velocities covered by normal condensing plant.

The actual values plotted are those for a rate of transmission of heat of 8000 B.Th.U. per square foot per hour, which is approximately the value obtained on an average in condensers for power stations. For values other than 8000 B.Th.U. per hour, the coefficient of transmission K_W should be increased by 0·2 per cent. for each increase of 1000 B.Th.U. per square foot per hour above 8000, and decreased by the same amount for each 1000 B.Th.U. per square foot per hour below 8000. For most practical purposes in condenser work, this small correction can be neglected.

Again, the results of Eagle and Ferguson's tests on tubes of different diameters in Fig. 5 of their paper can readily be used to find the adjustment necessary in Fig. 4 of this paper to make it applicable to tubes of external diameters other than ¾in. for the limited range of tube diameters used in condenser work, and for the almost universal standard condenser tube thickness of 18 S.W.G.

In this way Fig. 5 was produced for a mean water temperature of 60 deg. Fah., showing in the dotted curves how the rate of heat transmission K_W per square foot of internal tube surface varies with the internal tube diameter for water velocities of 3ft., 6ft., and 9ft. per second. The full-line curves present the same data expressed as a rate of heat transmission per square foot of external surface.

It will be apparent from Fig. 5 that by adopting the external surface as the basis for expressing transmission the effect of the variation in tube diameter on the coefficient K_W is very materially reduced as compared with using the internal surface within the range of tube diameter and velocities usual in condenser work. In fact, for most practical purposes, the effect of tube diameter can be neglected altogether, providing everything is expressed in terms of the external surface. Fig. 4 can, therefore, be used without material error for the rate of heat transmission on the water side of condenser tubes per square foot of external surface of either ½in., ⅝in., ¾in., or 1in. diameter tubes.

The error involved in this assumption is indicated directly by the table of corrections given below, which, when applied to Fig. 4, gives the correct heat transmission for tubes of ½in., ⅝in., and 1in. diameter :—

Water velocity.	Correction for tube diameter.		
	½in.	⅝in.	1in.
	Per cent.	Per cent.	Per cent.
9ft. per second	+1·4	+0·7	−3
6ft. ,, ,, ...	+1·0	+1·6	−1·9
3ft. ,, ,, ...	−3·5	−0·6	−1·1

RATE OF HEAT TRANSMISSION—STEAM TO TUBE, K_S.

The resistance to heat transmission from the tube to the water is, of course, $\frac{1}{K_W}$. It is convenient in analysing condenser tests to express the resistance through the tube itself and that from the tube to the steam by a single term $\frac{1}{K_S}$.

Then the overall rate of heat transmission K_T is $\frac{1}{K_T}=\left(\frac{1}{K_W}+\frac{1}{K_S}\right)$. We can, therefore, obtain K_S by analysing the overall transmission obtained in tests of actual condensers, and using for K_W the values obtained from Fig. 6.

It is necessary to exercise some care in the selection of the particular test to be used for this purpose. Firstly, because in actual practice, if the condenser is underloaded during the test, condensation may be virtually completed before the whole of the tubes have been traversed. Hence when the rate of heat transmission is deduced by dividing by the total surface of the condenser the apparent rate of heat transmission is reduced in proportion to the redundant surface. This condition can occur in winter with cold water even at the maximum rating of the plant.

Secondly, the condition on the water side of a particular condenser depends on its state of cleanliness, and the only reasonable way in which this variation can be controlled is by selecting tests in which the tubes have been wire-brushed or cleaned by acid or alkali solution prior to the test.

Extreme accuracy is necessary in the measurement of the water temperature, particularly at the outlet, and of the vacuum at the entrance to the condenser. As in these cases large sectional areas of flow are involved, several observations must be made over the area, or else special methods of sampling or averaging must be used to secure the true average condition.

The number of tests where all these conditions are satisfied is very limited. In any case the interpretation of actual condenser tests requires a considerable knowledge of the design of the condenser particularly concerned.

The authors have selected forty-six tests which reasonably fulfil these conditions, covering a considerable range of condenser sizes from 250 to 37,800 square feet, and have plotted in Fig. 6 values of K_S deduced from these tests by means of Fig. 4.

The dispersion of the points on Fig. 6 illustrates the difficulties associated with heat transmission investigations on actual condensers even when a high degree of accuracy in testing is obtained, and where precautions have been taken to secure commercial cleanliness. It must, however, be remembered that the tests shown relate to condensers covering a variety of types and cover a large range of other conditions.

For instance, the four points marked A were obtained from a condenser commercially clean, whereas the points marked B were obtained on the same condenser before cleaning. It is notable that the dispersion of these points is almost the maximum in the figure. The other main factors which probably contribute to this dispersion are :

(1) This method of analysing is very susceptible to the inaccuracy of even careful commercial testing, since an error in measurement of vacuum of from + to − 1/50th of an inch of mercury results in a variation of K_S on Fig. 6 of about 300 B.Th.U.

(2) The effect of redundant surface can depress the apparent rate of K_S very considerably if the condenser is not fully loaded. This latter point is illustrated by the dispersion of the points C, D, and E, applying to the same condenser. Of these, C was derived from tests taken at full load, D at three-quarter load, and E at half load.

(3) There may also be variations in the cleanliness of the steam side of the tubes sufficient to affect K_S although there is no means of controlling this factor in practice.

(4) The rate of heat transmission on the steam side may depend on the velocity and scrubbing action of the steam flow across the tubes, which may control the water film thickness in the steam side of the tube. The considerable variations in dimensions of the condensers involved in Fig. 6, together with the variety of tube plate arrangements, and shell configurations involved, admit of very considerable differences in this effect.

In order to study this possibility, the values of K_S for any one condenser were plotted against the equivalent steam velocity as defined earlier in this paper. While it was apparent that there was an appreciable effect of this kind, it did not seem possible to isolate it from the effect of redundant surface.

It is necessary to consider how the presence of a water film on the steam side of the tube may influence and control K_S.

The total resistance from the steam itself to the water side of the tube metal can be expressed as follows :—

$$\frac{1}{K_S}=\frac{1}{K_m}+\frac{1}{K_d}+\frac{1}{K_f}$$

Where $\frac{1}{K_m}$ is the resistance of the metal of the tube itself.

$\frac{1}{K_d}$ is the resistance of any film of dirt on the steam side of the tube.

$\frac{1}{K_f}$ is the resistance of the film of water which is continually being renewed on the steam side of the tube.

If it is assumed that the tubes are clean on the steam side, K_d drops out of consideration and the coefficient K_S can be calculated for an assumed water film thickness from the conductivity of water, its variation with temperature and the conductivity of the metal of the tube.

In this way, assuming a water film of 3/1000in. thickness, the rate of heat transmission on the steam side was calculated from Lee's data on the conductivity of water, and is plotted in the line L L on Fig. 6, whereas the line J J is that deduced from Jakobs' experiments.

It is of interest to note that the two curves give the variations in heat transmission with water temperature of opposite sign and that in both cases the variation is very small. On the other hand, the thickness of the water film may be expected to have a profound effect.

While originally Fig. 6 was plotted with water tempera-

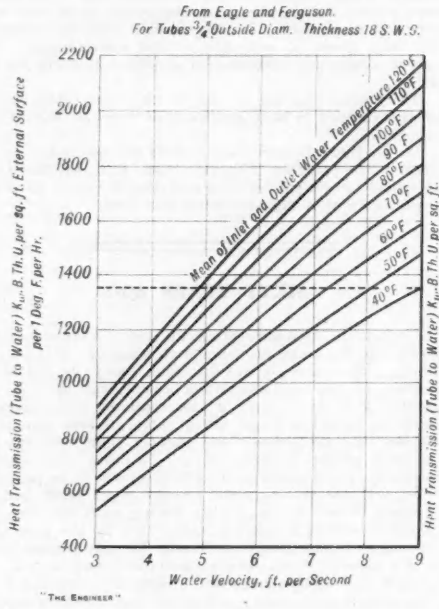


FIG. 4—*Heat Transmission from Tube to Water.*

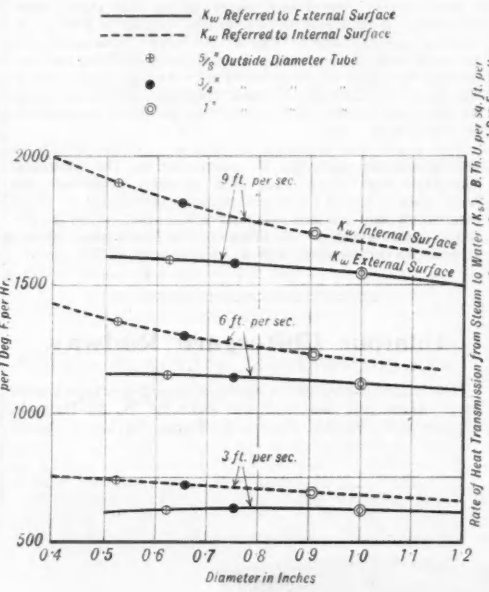

K_W Referred to External Surface
K_W Referred to Internal Surface
⅝" Outside Diameter Tube
¾" .. .. ..
1" .. .. ..
9 ft. per sec.
6 ft. per sec.
3 ft. per sec.
K_W Internal Surface
K_W External Surface
Heat Transmission (Tube to Water) K_W B.Th.U. per sq. ft. per 1 Deg. F. per Hr.
Diameter in Inches

FIG. 5—*Variation of Rate of Heat Transmission from Tube to Water with Tube Diameter.*

Condenser No.	Surface sq. ft.	Symbol
8	15,500	+
13	11,380	×
10	37,800	◇
15	19,100	●
18	10,000	◇
19	10,400	○

Condenser No.	Surface sq. ft.	Symbol
9	10,400	*
12	13,250	△
19	14,500	□
20	250	⊕
21	422	⊠
22	980	⊗

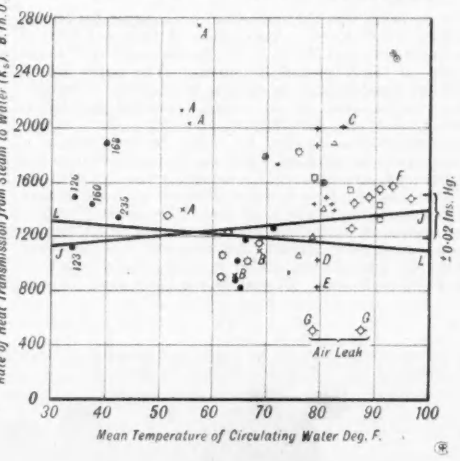

Rate of Heat Transmission from Steam to Water (K_S) B.Th.U. per sq. ft. per 1 Deg. F. per Hr.
±0·02 Ins. Hg.
Air Leak
Mean Temperature of Circulating Water Deg. F.

FIG. 6—*Heat Transmission Rates from Steam to Tube.*

* Read before the Institution of Mechanical Engineers, North-Western Branch, on February 1st, 1934.

ture as abaissae in order to see if this effects K_s sensibly, both the points plotted and consideration of Lees' and Jakob's curves suggests that the effect of water temperature is not material.

A decrease in film thickness of one-third, say, from 3/1000in. to 2/1000in., should in this manner result in a change in K_s from, say, 1200 B.Th.U. to 1800 B.Th.U.

(5) Air leakage unless in normal quantity and uniformly diffused throughout the mass of steam entering the condenser may, and has been found to upset the accuracy of the reading and the conclusion to be drawn from them in a most curious way.

For instance, point F was obtained on the same condenser as point G, and at the same loading, but was taken after an orifice admitting 10·5 lb. of air per 10,000 lb. of steam was opened at the inlet flange of the condenser.

While the apparent effect was to depress the rate of heat transmission on the steam side of the tube from about 1570 to 600 B.Th.U. per hour, the probability is that a considerable proportion of the surface became ineffective, due to air blanketing.

Further in this test the anomaly resulted that the apparent pressure drop in the condenser changed from a positive to a negative value.

In order to supplement the information on K_s certain points have been added on the left of Fig. 6 deduced from tests in regenerative feed heaters, the mean water temperatures being written against the points, as these lie beyond the scale of Fig. 6 itself.

In considering the whole of the evidence on Fig. 6, the authors have given due weight to the importance of regarding conservatively the few abnormally favourable points, if predicted performances are to be generally realised in the present state of knowledge and with condensers in a commercially clean condition. They feel justified in suggesting that a value of K_s taken as remaining constant with temperature within the range of Fig. 6, and equal to 1350 B.Th.U. per square foot per degree Fahrenheit per hour, affords the most judicious selection for establishing a series of overall heat transmission curves.

While they think there is some evidence that K_s should be variable with the U_e, the equivalent velocity on the steam side, this effect is relatively small in modern condensers in which the pressure drop should be kept relatively small. The exact effect is not sufficiently known at present to warrant the suggestion of anything but a constant value of K_s for practical design.

If this be so, inspection of the position of the 1350 B.Th.U. per 1 deg. Fah. per square foot per hour ordinate in Fig. 4, giving the rates of heat transmission from tube to water, suggests that on an average the resistance on both the water and steam sides of the tubes is in the main due to water films of substantially similar dimensions.

Total Overall Rate of Heat Transmission.—By using this value of 1350 B.Th.U. per square foot per degree Fahrenheit per hour for the mean coefficient of heat transmission on the steam side and the values of the heat transmission K_w on the water side, given in Fig. 4, the total heat transmission curves given in full lines in Fig. 7 were obtained for the range of water velocities and mean water temperatures encountered in ordinary condenser practice.

The rates of heat transmission given in Fig. 7 can be obtained on commercially clean condensers of good design with some margin to cover reasonable departures from the ideal condition.

It will be found that these curves can be expressed fairly closely by the formula

$$K = 650 \sqrt[2]{\frac{V_t}{5}} \times \sqrt[4]{\frac{t}{100}}$$

B.Th.U. per square foot per deg. Fah. per hour . . (7)

Where V_t = Water velocity in the tubes in feet per second.

t = Arithmetic mean water temperature between inlet to and outlet from the tubes.

The curves shown in dotted lines in Fig. 7 give the rates of heat transmission which were mutually agreed upon by the six principal U.S.A. condenser makers.

It is important to realise that these American curves are intended to be used with the Grashof logarithmic mean temperature difference, and without regard for the effect of pressure drop on the mean temperature difference. For no pressure drop, and at a mean water temperature of 60–70 deg. Fah., the U.S.A. values almost coincide with the authors', while the 40 deg. Fah. U.S.A. value is so low that it suggests it has been depressed to compensate indirectly for the effect of considerable pressure drop, or that its determination was influenced by experience in single flow condensers, where, as has been shown, the Grashof formula gives too great a mean temperature difference.

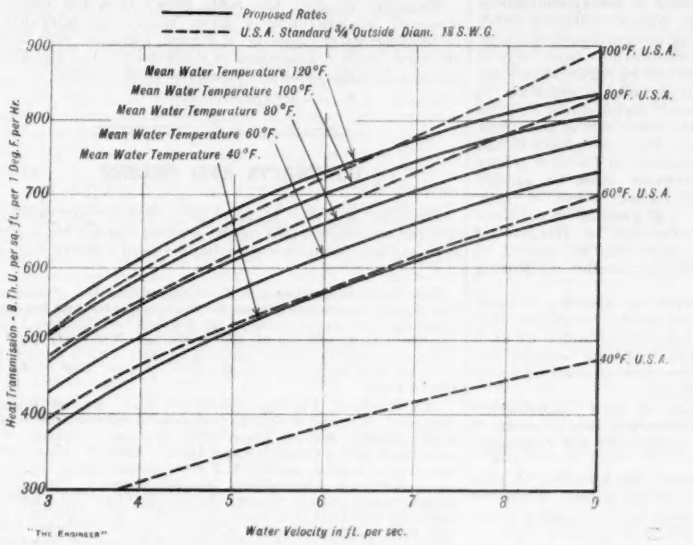


FIG. 7—*Rates of Overall Heat Transmission Steam to Water.*

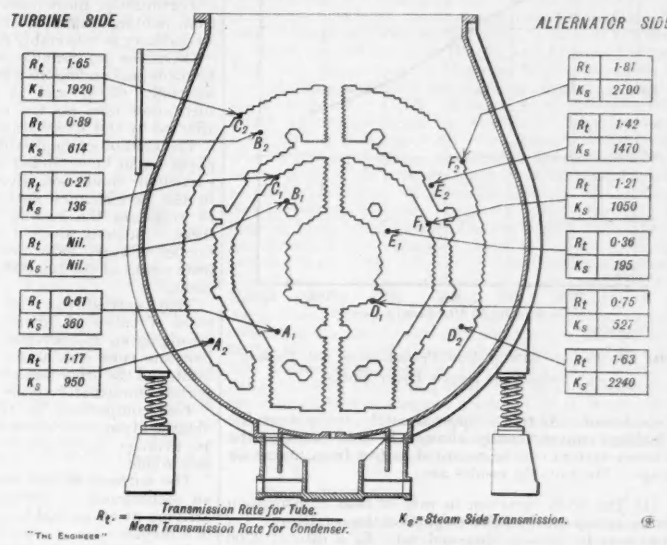


FIG. 9—*Individual Tube Heat Transmission Tests.*

Usually for a given power plant the steam consumption per unit output will be known at the prime mover coupling, so that the heat rejected to the condenser per pound of wet steam i_2 can be directly determined from the formula

i_2 = (heat at stop valve) − (heat converted into work) − (sensible heat in condensate)

$$= i_1 - \frac{2545}{D\eta_m} - i_4 \text{ B.Th.U. per lb.} \quad . \quad . \quad . \quad . \quad (8)$$

Where i_1 = Total heat at stop valve, B.Th.U. per lb.

D = Steam consumption in pounds of steam per B.H.P.

η_m = Mechanical efficiency of prime mover.

i_4 = Sensible heat of condensate, B.Th.U. per lb.

Exact knowledge of the mechanical efficiency of a particular machine is not necessary as the effect of small, variations is also small.

Thus for most purposes it is sufficient in the case of steam turbines to assume a value of 99 per cent. for machines of large capacity in relation to their speed of rotation and 98 per cent. for small turbines.

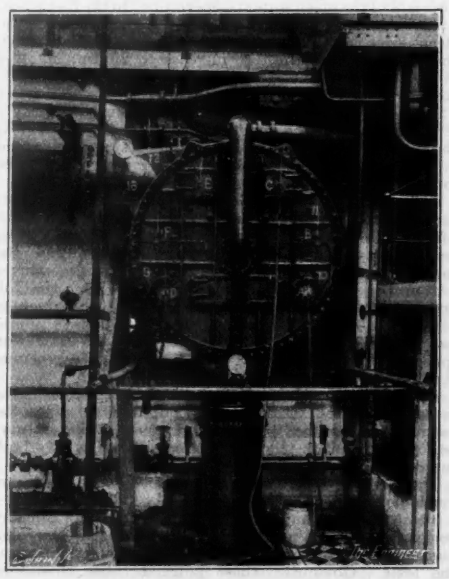


FIG. 8—*Arrangement for Individual Tube Tests.*

In order to see how widely the actual heat rejected to the condenser differs from the conventional 1000 B.Th.U. per lb., Table III. has been prepared covering an enormous range of steam conditions and machine capacity. It will be noted that the highest value is 96·7 per cent. of the conventional figure and the lowest 87·5 per cent. If, therefore, in analysing a test the correct quantity of heat abstracted is not used, but a figure of 1000 B.Th.U. substituted, it is obvious that a rate of heat transmission which would be deduced may be as much as 14 per cent. too high. The method just given for determining the heat rejected to the circulating water is also strictly true, both for systems fitted with air ejectors or for the case of complicated regenerative feed-heating systems, providing that in both cases the steam consumption D includes both the steam for the ejector and that condensed in the regenerative feed heaters, and that i_4 is the sensible heat of the condensate after the ejector heater or the last regenerative feed heater as the case may be. The latter condition requires that the drains from all such heaters return to the condenser and are measured with the condensate.

Heat Rejected to Circulating Water in Condensers.

One of the most unfortunate misconceptions which has dogged the development of condenser technology lies in the conventional assumption that the net heat abstracted in the condenser from the steam is the convenient number of 1000 B.Th.U. per lb.

It is obviously essential, both in the statement and analysis of condenser performance and in the determination of cooling surface required, that the actual total amount of heat abstracted must be known and used.

Of course, in modern power plant the steam entering the condenser is not dry, and, in fact, may contain, say, 10 per cent. of water.

The way in which this wetness fraction varies with prime mover efficiency and initial steam conditions in the range covered by modern plant has been set forth in an earlier paper by one of the authors, presented at this branch in 1929 ("Tendencies in Steam Turbine Development," "Proc.," Inst. Mech. E., 1929, Vol. I., page 453).

TABLE III.—*Approximate Heat Rejected to Circulating Water per Lb. of Condensate For Various Steam Conditions and Capacity of Plant.*

Steam conditions.	Heat rejected to circulating water, B.Th.U. per lb. of condensate.	
	Small plant.	Large plant.
1400 lb. per sq. in.:		
800 deg. F., 29in. vac. . .	912·47	877·10
,, ,, 28in. ,, . .	908·37	875·40
600 lb. per sq. in.:		
800 deg. F., 29in. vac. . .	967·25	913·25
,, ,, 28in. ,, . .	965·65	914·15
200 lb. per sq. in.:		
550 deg. F., 29in. vac. . .	948·18	905·18
,, ,, 28in. ,, . .	947·08	907·08
150 lb. per sq. in.:		
500 deg. F., 29in. vac. . .	952·50	896·50
,, ,, 28in. ,, . .	950·90	899·94

Individual Tube Heat Transmission Tests.

In order to investigate how different sections of the surface of a condenser function under actual working conditions, a test was made on a condenser of 16,600 square foot surface, in which the performance of individual tubes could be ascertained concurrently with a test on the condenser performance as a whole.

Twelve tubes—six in each pass—were isolated by fitting special ferrules which permitted a connection to be carried to the outside of the water box cover by means of stout rubber hose. Thus the water quantity flowing from the tube in the second pass could be measured and its final temperature observed.

At the reverse end the tubes were coupled in pairs with a connection through the door at that end to allow a sufficient quantity of water to be tapped off to permit the temperature leaving the tube in the first pass to be measured accurately.

In this way observation could be made on each pair of tubes in turn during a test on the condenser as a whole with the load conditions maintained as nearly as possible constant. The arrangements at the water box end are shown in Fig. 8.

In order to exhibit the varying performance in different parts of the condenser Fig. 9 has been prepared showing the positions of the individual tubes and the results obtained from them.

Against each isolated tube has been indicated the ratio R_t of the overall rate of heat transmission in that tube to the mean transmission for the condenser as a whole.

The rate of heat transmission on the steam side of the individual tubes K_s, deduced by using Fig. 4 for the rate of heat transmission on the water side, is also given.

During the series of tests the water velocity in the individual tubes was under a certain amount of independent control and was usually kept within the range from 5ft. to 7ft. per second, compared with a mean for the whole condenser of 6ft. to 6·5ft. per second.

In order to check how the overall rate of heat transmission from steam to water varied with velocity in the isolated tubes certain tests were made with velocities ranging from about 3ft. to 6ft. per second, and the results

confirmed that the heat transmission coefficient varied as the square root of the water velocity.

In the first pass the temperature rise averaged 9 deg. Fah. and in the second pass also 9 deg. Fah.

All deductions shown in Fig. 9 were obtained by reducing the observed results to a basic inlet water temperature of 75 deg. Fah. by means of the curves in Fig. 2 of Messrs. Eagle and Ferguson's paper and to a mean water velocity of 6ft. per second by correcting coefficients of heat transmission as the square root of the velocity.

Such corrections were small, as the variations from 75 deg. Fah. inlet water temperature and 6ft. per second water velocity were not great.

The quantity of air leakage during the tests was measured at the discharge from the ejector and was found to be 1·15 lb. of dry air per 10,000 lb. of steam entering

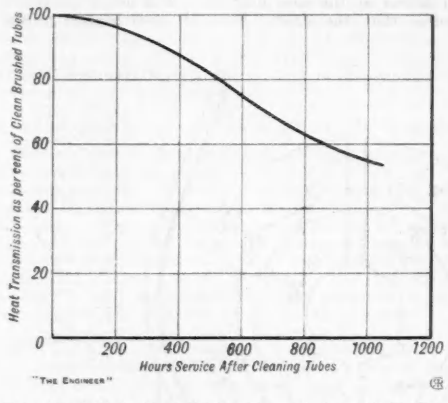


FIG. 10—*Fall in Rate of Heat Transmission with Fouling on Condenser at Barton Power Station.*

the condenser. As this is approximately one-quarter the air leakage conventionally allowed in this country, the condenser system can be regarded as free from undue air leakage. The notable results are :—

(1) The wide variation in rate of heat transmission on the steam side in different parts of the condenser. On the most favourably disposed tube F_2 a rate of 2700 B.Th.U. per square foot per deg. Fah. per hour was reached.

(2) That the tube D_2 immediately below F_2, but in the bottom half of the condenser, shows a rate of heat transmission on the steam side of 2240 B.Th.U. per square foot per deg. Fah. per hour in spite of the fact that in this position it might be expected to be drenched with the condensate from the higher tubes.

(3) That more heat is transmitted on the side of the condenser towards the alternator than towards the turbine.

(4) That following the radial line C_2 B_2 C_1 B_1 condensation appears to be completed before the centre of the nest is reached. The same appears true of the radial line F_2 E_2 F_1 E_1.

(5) That following the radial line D_2 D_1, the comparatively high performance of tube D_1 at the centre is probably due to the access of steam to the tubes in the first pass at this point *viâ* the unbaffled lane provided from the bottom of the condenser, an observation which led to some modification of later designs.

(6) In general the lower half of the condenser is contributing equally with the top half to its effective performance, again suggesting that the cascade of condensate from the top to the lower tubes is not materially interfering with the performance.

Incidentally, the mean temperature of the condensate during the tests was from ½ deg. to 1 deg. Fah. higher than that corresponding to the mean vacuum at the condensate inlet.

The authors offer no explanation of this phenomenon, although they have observed in several cases this anomaly of an excess of condensate temperature above the observed mean vacuum temperature of up to 5 deg. Fah., in spite of the greatest care in observing temperatures and the vacuum pressure itself.

The single tubes used in the test just discussed were installed when the condenser was built, and therefore had been operating under exactly the same conditions as the remaining tubes throughout the nine months which elapsed before the tests were made.

On completion of the tests just described six out of the twelve isolated tubes were replaced with new tubes from a commercial stock.

Tests on these new tubes gave results not measurably different from those obtained with the tube replaced. It should be pointed out that the condenser operated in conjunction with cooling towers under which conditions the rate of fouling is often extremely slow.

Effect of Cleanliness of Water Side of Tube on Rates of Heat Transmission.

In the previous discussion the assumption throughout has been that the tubes are commercially clean ; that is, in the state that can be produced by wire brushing or chemical cleaning.

It is necessary to consider the changes in performance which may result from what may be called commercial fouling of the tubes, since this is, after all, the condition under which—in varying degree—the plant must operate for most of its working life.

A local example of the effect of fouling on vacuum was presented in Figs. 13 and 14 of the paper "Operating Results with the Recent Extensions at Barton Power Station" presented by Guy and Lamb to the Institution at this branch in March, 1930 (Inst. "Proc.," Vol. II., 1930, page 644).

By translating the latter figure into terms of the fall in heat transmission with time on this particular installation Fig. 10 is obtained, showing that after a slow fall in the first 200 hours the rate of heat transmission decreased almost in a straight line by 40 per cent. in 800 hours.

Landis and Tucker have published (*Power*, 1933, Vol. 77, page 308) the fact that the rate of heat transmission fell 38 per cent. in one year on the 160,000-kW set at Hudson-avenue, where the water velocity through the condenser tubes is 6ft. per second.

On the other hand, in the single-tube tests of the cooling tower installation discussed earlier, no measurable improvement in rate of heat transmission with new tubes was observed compared with the original tube after nine months' service.

Obviously, until some means is established of standardising degrees of fouling and their relation to heat transmission, it is manifestly impossible for manufacturers of condensing plant to guarantee performance in any other condition than that of a clean condenser.

It is, unfortunately, not always convenient or even possible to clean a condenser thoroughly before contract tests have to be made.

Fortunately, most users are able to satisfy themselves from readings taken in ordinary station routine whether a condenser is reasonably fulfilling its contract obligations.

Occasions do, however, arise when careful tests have to be made on condensers which cannot be regarded as commercially clean, and it is important to establish in such cases how far the condenser performance may be affected by the actual state of the water side of the tubes.

The method of single-tube tests described earlier in this paper might be extended to determine in the case of any particular condenser what correction must be applied to the performance determined during a test in order to translate the results into performance with clean tubes. Such a method was described by Hardie and Cooper (*Power*, 1933 Vol. 77, page 154) as applied to tests made on the 160,000-kW Hudson-avenue condensing plant.

They carried out this method by isolating several pairs of tubes in different parts of the condenser and arranging an independent discharge from each. Of each pair one tube was placed in the condenser when it was built, and the other was a new tube inserted in an adjoining portion immediately prior to the test.

The comparison in the rate of heat transmission obtained from the new and old tubes was used to establish an average correction to be applied to the condenser as a whole.

The authors do not recommend the adoption of such an elaboration in testing, except as a final means of arriving at an equitable settlement in the unhappy event of a dispute.

In such cases it would be of first importance to ensure that the adjacent old and new tubes were really in similar positions in the stream of steam and water. In fact, this method is only logically satisfied if, after a first test, the new and old tubes are interchanged and the tests repeated.

When the possibility of having to resort to this expedient is visualised at the ordering stage, it would be desirable to arrange for a considerable number of manhole doors on the end covers of the condenser, since these provide convenient means of bringing out the connections from the isolated tubes, as illustrated in Fig. 8.

The Provision of Margin to Cover Average Fouling.

While these proposals from the manufacturers' point of view dispose of the difficulty which arises from fouling, the user is still concerned with the fact that his condenser performance is falling as fouling proceeds, and naturally he may wish to specify some margin to cover this condition.

The provision of such a margin is by no means so simple a matter as is generally supposed. It is not sufficient and, in fact, may achieve nothing, to specify an abnormally large condensing surface. This would inevitably result in the incidence of competition being directed to reducing the water quantity, leaving the *true* criterion—the rate of heat transmission—unchanged with no advantage secured in regard to average vacuum.

Nor is it desirable to attempt to obtain the desired margin by specifying a higher vacuum than that economically appropriate to the mean water temperature. In the first place, if this is done by calling for a $^1/_{16}$in. higher vacuum, the effect varies very much with the actual vacuum obtained. Thus, at 29in. vacuum, the increase to 29·1in. involves an increase in surface of 25 per cent., while $^1/_{16}$in. at 28in. vacuum corresponds only to 9 per cent. increase in surface.

Secondly, this increase in vacuum will almost inevitably be carried over to the design of the prime mover, and as Baumann has shown, the increase in its cost at 29in. would be 3·5 per cent., for which no proper return would be obtained in operation.

It is equally undesirable to specify a higher water temperature than that of the annual mean, weighted with reference to the variation in load throughout the year, because if a higher temperature is specified and the appropriate economic vacuum adopted, the prime mover will probably be smaller than desirable, and the full gain from the higher vacuum possible in the colder months will not be obtained. Further, it is not always appreciated that under such conditions the air extraction apparatus will be smaller than desirable and the vacuum in colder months limited for this reason.

If, on the other hand, a higher temperature than the average weighted mean is specified, together with the vacuum appropriate to the latter temperature, it may be found that it is physically impossible to satisfy both conditions.

Two quite practical methods of specifying margins are available.

The condenser may be called upon to give its contract performance with a predetermined percentage of the tubes plugged so as to render their surface ineffective during the tests. Obviously, these plugged tubes should be uniformly distributed throughout the tube nest. Reasonable margins to specify in this way are 5, 10, or 15 per cent., depending on the rapidity of fouling to be expected in service.

When such a condenser is in normal service with the tubes unplugged, the performance is improved not only by reason of the increased surface provided in this way, but also by the increased water flow resulting from the decreased friction head against which the circulating pump then operates.

The following table gives the approximate increase in vacuum which can be obtained in this way in a syphonic installation with constant speed pumps of normal characteristics :—

Percentage of tubes plugged	5	10	15
Decrease in vacuum temperature, deg. F.	0·74	1·36	2·06
Increase in. vacuum at 29in. Hg.	0·02	0·04	0·06
„ „ „ „ 28in. „	0·04	0·06	0·12
Increase in circulating water to produce additional vacua given above, per cent.	5	10	15·5

Alternatively, the margin may be obtained by increasing the circulating water quantity as the condenser becomes fouled. This is quite convenient if water is supplied by a separate multiple-unit pumping station, or by the use of variable-speed pumps. If the pumps are tied in with the condensing plant and are of the constant-speed type, this expedient can be partially obtained by installing pumps of a larger capacity than sufficient for the normal performance of the condenser when clean.

Strangely enough, the table shows that the margin obtained by providing a given percentage additional circulating water capacity is almost identical with that obtained when a condenser is designed for the specified vacuum with the same percentage of tubes blocked.

(*To be continued.*)

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

The Integra Company, Ltd., Birmingham, 15, informs us that the pyrometric equipments for the atmospheric and vacuum distilling units to be installed at the Lobitos Oilfields, Ltd., Ellesmere Port, will be of the Leeds and Northrup system. These instruments will be supplied by the Integra Company, Ltd., through the refinery contractors, Messrs. Alco Products International.

The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, has received a contract for seven large induction motors, phase advancers and switchgear, for installation in the Kemsley Paper Mills of Edward Lloyds, Ltd. Each motor is rated at 2500 H.P. when running at 250 r.p.m., on a 6600-volt, three-phase, 50-cycle supply. The phase advancers will provide for power factor correction to 0·9 leading when the motors are running at full load. The control gear for each motor will consist of an oil circuit breaker of 500,000 kVA breaking capacity, and a motor-operated liquid starter, a separate control panel being supplied for each machine. The contract also includes a fifteen-panel, 6600-volt switchboard of the truck cubicle design. The oil circuit breakers are to be motor-operated, and have a breaking capacity of 500,000 kVA, those for the motor circuits being remote-electrically operated from the motor control panels. The whole of the equipment will be designed and manufactured at the Engineering and Switchgear Works of the General Electric Company, Ltd., at Witton.

EDUCATIONAL INTELLIGENCE.

University of London, King's College, Strand, W.C.2.—In the Department of Mechanical Engineering, King's College, Strand, a course of three lectures will be given on Tuesdays, at 5.30 p.m., on the Fatigue of Metals : A Survey of the Present State of Knowledge, by H. J. Gough, F.R.S. Admission free, without ticket.

Institute of Industrial Administration.—Mr. Harold MacMillan, director of Macmillan and Co., Ltd., the Great Western Railway, and the Monotype Corporation, Ltd., has accepted the office of President of the Institute of Industrial Administration for 1934.

Finsbury College Dinner.—The twenty-second Finsbury Technical College Old Students' Association's dinner will take place on Saturday, March 17th, at the Trocadero Restaurant. Any Old Students who are not on the register should apply for particulars to Mr. F. R. C. Rouse, at 15, Clifton-gardens, Golders Green, N.W.11.

Greasy Floors.—A new de-greasing colloidal substance, particularly useful for greasy floors, is known as HF-Colosyl-XTL. It is simply mixed in hot or boiling water, poured over the grease-caked floor, and brushed about, preferably with a wire brush. The "Colosyl" emulsifies the grease and rapidly reduces it to a mud-like sludge which may be swilled away with clear water, leaving the floor thoroughly cleansed. It is manufactured by Industrial Colloids, Ltd., of Manchester, and the sole distributors are Harvey Frost and Co., Ltd., 148, Great Portland-street, W.1.

Mr. Alfred Lucas.—Mr. Alfred Lucas, who died in Sheffield on February 6th in his seventieth year, was for 33½ years manager of the Sheffield District office of the British Thomson-Houston Company, Ltd., from which position he retired a year ago. For fourteen years he was with Tasker, Sons and Co., and during this period helped to carry out many of the early electric lighting and telephone installations in Sheffield. As assistant manager of the firm, the first Sheffield electric light works was built under his supervision. When the Sheffield Electric Light and Power Company was taken over by the Corporation in 1897, Mr. Lucas went with it as superintendent of mains under the Electric Lighting Committee. A year and a half later, early in 1899, he became Sheffield district manager for the B.T.H. Company.

The Institution of Electrical Engineers.—The annual dinner of the Institution of Electrical Engineers was held at Grosvenor House, on Friday, February 9th. Between seven and eight hundred members and guests were present. Congratulatory messages were read by the President, Mr. P. V. Hunter, from the corresponding electrical bodies in France and Belgium. In proposing the toast of "The Institution," the Minister of Transport, Mr. Oliver Stanley, referred to the marked progress the electrical industry had made. Almost every month since 1930 there had been an unbroken record in its progress, and during last year the consumption of electricity reached the large total of 13½ thousand million units, representing a 10 per cent. increase compared with 1932. On one of the cold days before Christmas the London Power Company generated no fewer than 5,600,000 units during the course of twenty-four hours. After the President had responded, Lieut.-Colonel K. Edgcumbe submitted the toast "Our Guests," which was replied to by Lord Rutherford, who referred to the great importance of research for new applications of electricity. He expressed the hope that there would be a further increase in the research institutions which would lead to big developments in electrical engineering.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Continental Steel Markets.

Brighter conditions have characterised the Continental steel trade during the past week or two, and the times required for delivery are becoming rather longer. In Germany there has been a fairly steady demand from the home market, which has enabled the makers to regard with less concern than would otherwise have been the case the slow development of export trade. The German producers make no secret of their alarm at the strength of Japanese competition in the Far East. Recently the Japanese made an interesting move by establishing an export office in Milan, and this is taken to indicate that their competiton in the cheaper descriptions of steel is likely to be a permanent factor in the world's markets. Suggestions have been made that it may be possible to reach an agreement with the Japanese regarding markets, but this may not prove easy, as the latter are keen bargainers and are scarcely likely to circumscribe their efforts until they have a shrewd idea as to the extent to which they may hope to expand their export trade. The French steel makers as well as the Belgians are equally concerned about this competition, although apparently they have not lost so much business as have the Germans. The French home demand for steel has been interrupted by the political troubles which have disturbed public confidence this year, and at the same time export business as directed by the Cartel has not produced the volume of business which the industry expected. Whether more business would have been secured by the old system, however, is at least arguable. The Belgian and Luxemburg steel makers, who are practically dependent upon overseas trade to keep their plant in operation, are better off for orders than for some time. This has encouraged some of the rerolling works which were closed down to contemplate restarting and some of the larger companies are also credited with the intention of starting fresh blast-furnaces. This has created alarm amongst the members of the Cartel, who fear that production under the stimulus of higher prices will soon begin to exceed the demand. All the Continental countries are receiving the support of railway companies, and this week the Belgian National Railways decided to place an order for 2000 steel railway carriages in addition to the 1800 ordered a short time ago.

Pig Iron Prices Raised.

The market was taken by surprise at the announcement made towards the end of last week of an increase in the prices of foundry grades of pig iron. The advance of 5s. per ton is general in all districts and makes the price of Cleveland No. 3 foundry 67s. 6d.; Northamptonshire No. 3, 67s. 6d.; Derbyshire, 71s.; and of Scotch foundry G.M.B., 70s. For some time past consumers had expected higher prices, and the producers made no secret of their dissatisfaction with the rates that had been current for a long period, in view of the advances that had occurred in coke, ore, and other raw materials. A fortnight previously, however, the Central Pig Iron Makers' Association had met and decided not to raise the price of Midland irons, and it was understood that this decision would stand until the usual monthly meeting of the Association in March. Following the announcement with regard to foundry iron, it was stated that the price of hematite would also be advanced by 5s., but in this case the increase has not been generally observed, although most of the makers appear to have adopted the new price. The North-West Coast and Welsh makers, however, have not altered their quotations, although an advance was expected. Probably stocks have not been liquidated to the same extent as in other districts.

The Pig Iron Market.

A feature of the pig iron market is still the scarcity of Cleveland foundry iron. The position is no worse than for several weeks past, but, on the other hand, consumers are not finding it easier to obtain supplies. Out of twenty-three furnaces operating on the North-East Coast, only four are producing Cleveland iron, and there seems little likelihood at the moment of the make being increased. Local, as well as Scottish consumers, make no secret of their desire to place forward contracts, but whether they will be so eager now that the price has been advanced remains to be seen. If they do, the higher prices may encourage an expansion of production. At the moment there is little unsold stock in the makers' hands, so that not much prompt iron is available for the open market. In the Midlands also the makers occupy a strong position, and until the prices were raised the Northamptonshire furnacemen were confining their business to prompt lots and an occasional renewal of an old contract for an important customer. The demand for this class of iron has been increased by the difficulty of securing Cleveland iron, but in the expectation, probably, of higher prices, the makers have been rather reluctant sellers. The Derbyshire producers who have fairly heavy stocks on their hands have been more willing to do business, although their price, which is based on 71s. d/d Black Country stations, is more expensive by 3s. 6d. than Northamptonshire brands. The demand is particularly good from the light castings industries, both in Scotland and in England, but lately there has been an improvement in business with the general engineering industries. There has been some decline in the demand for hematite iron, but the position is still tight as regards forward supplies, although here, again, the situation may be altered by the rise in price. The North-East Coast makers report that the output is being absorbed and the stocks greatly reduced, and the North-West Coast makers also are experiencing a good demand. This week little business was done, but price movements are usually followed by a lull. Considerable business has passed in basic iron, but only a small proportion of this comes on the open market, as most of the output is taken by works allied to the producing concerns.

Semi-finished Steel.

After a long period during which they were hard pressed to keep up with the demand, the producers of billets have experienced slightly easier conditions which may partly be due to the advance in price. The rush of consumers to secure their forward requirements has passed, and most users have entered into forward contracts for some distance ahead. There is, of course, a steady demand, but this largely consists of small orders for supplementary tonnages. The producing works, also, having put more plant into operation towards the end of last year, are now in a better position to cope with the demand, and little is heard of the delays in delivery which were becoming common in December. The position varies somewhat in the different districts. In Lancashire the demand for billets is steady, but little forward business has been done this week. The official quotation of £5 5s. for 500-ton lots was practically nominal long before the official price was increased to £5 10s., and in some cases a premium is now asked. In Scotland and the Midlands the demand also has been for fairly near delivery, but the buying in these districts has not been so active of late. The volume of business in sheet bars has never attained the same proportions as for billets since the duties were imposed, and lately the quiet conditions that have ruled in the sheet and tin-plate trade have reacted sharply upon the demand for the semi-finished material. Recently, some producers have shown themselves rather anxious to obtain orders, and the quotation of £5 5s. has been shaded at times. The advance in the price of acid basic billets to £9 7s. 6d. basis has not affected the demand. In fact, business, if anything, has been rather better since the increase. Competition in the home market from Continental makers has been stronger of late; but has been interrupted at times by the movement of the exchange. Quotations are at £5 10s. for billets 2in. and 2¼in. The nominal quotation for Continental sheet bars is £5 delivered to most districts, but there is practically no demand at this figure.

The Midlands and South Wales.

This has been rather a disappointing week so far as new business is concerned. Until recently the busiest section of the market probably was that dealing in small steel bars, but the advance in price last week from £7 10s. to £8 12s. less a discount of 2s. 6d. has checked business. Reports had been current that an increase was contemplated, but when the new price came into force there seemed to be considerable confusion as to the actual position and for the time being business dried up. Some of the buying since Christmas may have been in anticipation of the rise, and if consumers are well covered the market may remain quiet for a time. It will be interesting to see if the Continental steel makers will take advantage of the position created by the upward movement in British material to advance their prices. At the moment Continental merchant bars are selling at £6 17s. to £7 d/d, including duty. Another feature of the situation is that all the re-rollers are not included in the scheme, and it has been possible this week to buy British steel bars at some shillings below the new official figure. The price of ferro-concrete bars is fixed at £7 10s. and bolt and nut bars are quoted at £7 10s. for 100-ton lots and £7 15s. for lots of less than 100 tons. Business in strip, which has also been brought under control, has continued fairly active; but this is probably because strip for making gas, steam and water tubes is outside the scheme. The British quotation for strip is £9 1s. for 4-ton lots against the d/d Continental price of £7 17s. 6d. to £8 10s. One of the disappointing features of the market is the poor demand for structural steel, and few of the Midland constructional engineers seem to be engaged upon important jobs. The South Wales tin-plate market has improved slightly during the past week and the cheap offers which were upsetting business have disappeared. For a week or two now sales have been in excess of production, the home trade as well as the export markets having bought on a fair scale. This has naturally had a favourable reaction upon the activity at the steel works.

The North-East Coast and Yorkshire.

The quietness noticed last week in business in the finished steel branch is still in evidence. The works, however, have a considerable tonnage of orders in hand, not only for railway material, but also for most descriptions of finished steel. It is expected that the demand from the shipyards will shortly expand and provide some long-awaited orders for shipbuilding steel. At present most of the business in this class of material comes from the ship repairing yards, which are taking a substantial quantity of steel. The constructional engineering shops in this district are only moderately employed. Anticipations held a short time ago that there would be an increase in the demand for structural material have so far not been realised. A satisfactory feature of the position is the increase in the volume of orders of a miscellaneous character resulting from the improvement in the position of many of the smaller engineering concerns. Export business has been poor and competition from the Continent in overseas markets seems to have increased. American makers also are actively seeking export business. The recent fluctuations of the exchange may help the British works and have certainly caused an increase in the prices asked for Continental steel. Busy conditions continue to rule in the Yorkshire steel markets, and most of the Sheffield works producing the lighter descriptions of steel are experiencing a pressing demand. Some of the heavy engineering firms have better order books than for some time past. The most active departments until recently were those producing small bars, bright drawn bars, stainless steel sheets, and steel strip, but, naturally, after the recent advance in prices, new business may be held up for a time.

Current Business.

The Government decision to assist the shipping companies to complete the construction of the Cunarder on the Clyde and the prospects of another large ship being built at Belfast, have naturally been received with favour by the steel trade. In addition, an order has been placed with Swan, Hunter and Wigham Richardson, of Wallsend-on-Tyne, for an 8500-ton motor liner for the carriage of dairy produce, fruit and meat from Australia and New Zealand to this country. The London, Midland and Scottish Railway Company has placed a contract for 100 third-class vestibule coaches with the Birmingham Railway Carriage and Wagon Company, Ltd., and the Metropolitan-Cammell Carriage, Wagon and Finance Company, Ltd. The Department of Overseas Trade announces that the following contracts are open for tender:—Argentine State Oilfields: Drills, Buenos Aires (March 14th); South African Railways and Harbours: fifty locomotive class 19C 4–8–2 type, 3ft. 6in. gauge, Johannesburg (March 12th); Uruguay, Institute de Quimica Industrial: 50,000 kilos. of old or scrap copper wire for manufacture of sulphate of copper, Montevideo (March 16th); India, North-Western Railway, Lahore: Rings, piston, valve floating type, Agent's office, Lahore (March 1st); also one locomotive boiler, saturated, for "G" class 2–8–2 type engine (March 12th); Egypt, Ministry of Finance Survey Department: Rails, new or second-hand up to 3850 tons, Egypt (March 17th); Department of Industry and Agriculture, Tehran, Persia: Rails, turntables, switches, electric hoists, steel cable and truck axles, Persia (March 6th); Mexico: H.M. Consul-General reports that a local firm desires to be placed in touch with manufacturers of flat cold-rolled low-carbon steel strip or sheet suitable for the manufacture of hinges; Canada: H.M. Senior Trade Commissioner in Canada and Newfoundland reports that a firm in Montreal wishes to be placed in touch with U.K. manufacturers of waterworks valves.

Ferro-alloys.

The market for ferro-alloys has failed to develop in the New Year, and transactions in practically all departments have been confined to odd lots. This is disappointing, as the expansion in the demand for special and alloy steels might have been expected to lead to a better call for ferro-alloys. Consumers, however, probably covered themselves during the spell of active buying several weeks ago. This was particularly noticeable in the ferro-silicon market, all large users having bought their first quarter requirements. Little more than hand-to-mouth buying, therefore, is expected for a time. Deliveries against contracts, however, are proceeding at a good rate, and, at the same time, there is a steady turnover of light parcels to some of the smaller users. Business in ferro-chrome also has been confined largely to hand-to-mouth transactions for immediate delivery, but it has not been altogether easy to obtain supplies of this alloy. The market is firm and, if anything, prices have a tendency to advance. The slight scarcity is due to drought in the producing countries, particularly those in which electrical power is used by the works. Some good business is reported to have taken place in silico-manganese, and there is some inquiry for forward delivery. Here, again, the shortage of water power has created some tightness in the position. Business in ferro-titanium is increasing, and there are fairly good prospects that the consumption of this alloy will improve during the spring. Considering the activity in special steels the demand for ferro-tungsten has been poor, but latterly there has been a considerable volume of inquiry, which so far has failed to develop into business. Export transactions in ferro-vanadium have improved slightly, but, on the whole, little change has occurred in this market for some weeks. There has been a poor demand for ferro-molybdenum, ferro-phosphorus, and ferro-cobalt.

Copper and Tin.

The improvement in the demand for electrolytic copper noticed last week has not been maintained, and trading in practically all markets has been confined to small parcels. The political disturbances in France, also, have had an adverse effect upon business, as that country is a large consumer. The American market has been quieter, and the repeated difficulties which have arisen in the "code" negotiations have had something to do with the contraction in the demand. The American price has been held at 8c. d/d, and the export price at 8·20c. c.i.f., which is equivalent to about £36 10s. Prices in the London standard market have fluctuated within narrow limits, and beyond a few hedging transactions there has been no development of any importance. Some buying took place towards the end of last week, which may have been investment buying as a safeguard against currency depreciation resulting from the political troubles on the Continent. Later on, however, sentiment in the market became rather bearish, and sales were more in evidence. . . . The tin market has presented few features of interest, but, notwithstanding the comparatively small turnover, the undertone remains firm. The general attitude seems to be one of waiting for something to turn up which may again arouse interest in this market. It is suggested that this may come in the shape of a renewed buying movement from the United States, particularly as it is believed that stocks in users' hands have been heavily drawn upon of late. The fluctuations of the dollar exchange also may lead to the market buying tin as a hedge against currency depreciation. There has been little business transacted with the Continent, although the Soviet Government has made some purchases. There is little speculation in the market as prices are too much under control to attract this class of business. In mid-week some American buying aroused anticipations that the long expected buying movement from that quarter had commenced; but the quantities taken up were not large.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Hematite Mixed Nos.	3 7 6	3 0 0
No. 1	3 8 0	3 0 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 10 0	3 1 0
No. 3 G.M.B.	3 7 6	2 18 6
No. 4 Forge	3 6 0	2 17 0
Basic	3 5 0	—
MIDLANDS—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic	3 10 0	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d	3 6 0	—
N.W. COAST—		
Hematite Mixed Nos.	3 15 6 d/d Glasgow; 4 0 6 „ Sheffield; 4 5 6 „ Birmingham	

(*Basic iron prices subject to a rebate of 5/–.*)

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
LANCS.—		
Crown Bars	9 0 0	—
Best Bars	9 10 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
MIDLANDS—		
Crown Bars	8 10 0 to 9 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	6 15 0 to 7 10 0	—
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	10 5 0	9 15 0
N.E. COAST—		
Common Bars	9 5 0	8 15 0
Best Bars	10 5 0	9 15 0
Double Best Bars	10 15 0	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
LONDON AND THE SOUTH—		
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	—
Plates, ¼in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 7 6	8 5 0
NORTH-EAST COAST—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 0 0
Plates, ¼in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 2 6	8 5 0
Boiler Plates, ¾in.	8 5 0	7 12 6
MIDLANDS, AND LEEDS AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 0 0
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 2 6	8 5 0
Boiler Plates, ¾in.	8 5 0	7 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
GLASGOW AND DISTRICT—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 0 0
Plates, ¼in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 2 6	8 5 0
Boiler Plates	8 5 0	7 12 6
SOUTH WALES AREA—		
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 0 0
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 7 6	8 5 0

IRELAND—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 10 0	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	8 15 0	8 15 0
14-G. to 20-G., d/d	10 0 0	9 0 0
21-G. to 24-G., d/d	10 5 0	9 5 0
25-G. to 27-G., d/d	10 17 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	12 15 0
2-ton to 4-ton lots	13 2 6
Under 2 tons	14 15 0

Export: £16 7s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets Free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel ports, 16/3 to 16/6.
Tin-plate Bars, d/d South Wales Works, £5 0s. 0d.

Billets.	£ s. d.
Basic, Soft (25·41% C.)	6 0 0
„ Medium (0·42% to 0·60% C.)	6 17 6
„ Hard (0·61% to 0·85% C.)	7 7 6
„ „ (0·86% to 0·99% C.)	8 7 6
„ „ (1% C. and up)	8 17 6
Soft (up to 25% C.), 500 tons and up	5 5 0
100 tons	5 12 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/9 per lb.	
Ferro Tungsten	2/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 12 6	7/–
„ „ 8 p.c. to 10 p.c.	£21 12 6	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£37 10 0	11/–
„ „ „ 1 p.c. carbon	£38 10 0	11/–
„ „ „ 0·70 p.c. carbon	£42 0 0	12/6
„ „ „ carbon free	10½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (per ton)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 7 6 scale 5/– p.u.	
„ „ 75 p.c.	£17 0 0 to 17 10 0 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	5/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£225 to £230	
Ferro Cobalt	5/3 per lb.	

NON-FERROUS METAL.

Official Prices, February 14th.

	Home.	Export.
COPPER—		
Cash	£32 17 6 to £32 18 9	
Three months	£33 0 0 to £33 1 3	
Electrolytic	£35 15 0 to £36 5 0	
Best Selected Ingots, d/d Birmingham	£36 10 0	
Sheets, Hot Rolled	£64 0 0	
Tubes, Solid Drawn (basis)	10d.	10d.
„ Brazed (basis)	10d.	10d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£30 0 0 to £31 0 0	
Tubes, Solid Drawn, 2/1 alloy	9d.	9d.
„ Brazed	11d.	11d.
TIN—		
Cash	£225 15 0 to £225 17 6	
Three months	£225 10 0 to £225 12 6	
LEAD	£11 11 3 to £11 17 6	
SPELTER	£11 16 3 to £15 2 6	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Grangemouth)—Navigation Unscreened	13/3 to 13/6
„ Glasgow— Ell	13/6 to 15/–
„ „ Splint	16/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	12/3 to 15/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	13/3 to 13/6
Unscreened Navigation	12/3 to 13/–
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	13/– to 13/6
Secondary Steam	12/6 to 12/9

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	17/6 to 20/6
Furnace Coke	13/– to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	14/– to 14/6
„ Second	13/– to 13/3
„ Best Small	10/6 to 11/–
Unscreened	12/– to 13/6
DURHAM—	
Best Gas	14/8
Foundry Coke	17/– to 19/6

SHEFFIELD— Inland.	
Best Hand-picked Branch	27/– to 28/–
South Yorkshire Best	22/– to 24/–
South Yorkshire Seconds	17/6 to 19/6
Rough Slacks	6/– to 9/–
Nutty Slacks	7/– to 8/6
Furnace Coke (at ovens)	12/3

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Steam Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/–
Foundry Coke	21/– to 36/–
Furnace Coke	19/6 to 20/–
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	35/– to 38/6
Machine-made Cobbles	35/– to 48/6
Nuts	37/6 to 48/6
Beans	25/– to 30/–
Peas	18/– to 20/6
Rubbly Culm	9/6 to 10/6
Steam Coals:	
Large	18/– to 20/–
Nuts	18/– to 25/–
Smalls	11/– to 13/–

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ½d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Engineering Outlook.

THE engineering industries and other branches of national activity are passing through the same phase as they did in Great Britain during the gloomy period of 1931. They suffer from extravagant expenditure on social services, which imposes intolerable burdens on all producers, from attempts to substitute State ownership and control for private enterprise, and from a collapse of national finance, a suppression of credit for industrial undertakings, and steadily increasing unemployment. They are all heading towards disaster. As the French constitutional system did not allow of a peaceful escape from this alarming state of things, the violent popular revolt could only be appeased by the formation of a National Government. The atmosphere is now being cleared, and the prospect of a more orderly control of the economical life of the nation has given more confidence in the immediate future of trade. There is much to be done to lessen the burdens on manufacturing industries and lower costs, and enable producers to sell their goods in competition instead of sheltering themselves behind a wall of prohibitive import tariffs and quotas. The solution of the whole problem of tariffs and quotas lies in manufacturers being able to get down their production costs to a world level. Unless they can compete in price on the open market the engineering industries will always be dependent on requirements at home and in the Colonies. Until the last few years most of the big firms were employed largely on work for national defence, as well as on material supplied to other countries for defensive equipment, but this course of activity has practically ceased with the necessity of all countries exercising the strictest economy. Their chief hope now lies in the carrying out of public works which are of so extensive a character that, if money can be found to put them in hand, there should be fair general activity in railway construction, bridge building, harbour and other works for some time to come. The need for economy and a repugnance to incur further national liabilities in the way of public loans, may limit the possibilities of financing these schemes, but the swing-over to an attempt to reorganise the conditions of finance and industry on a rational basis has, nevertheless, definitely improved the engineering outlook.

Coal.

Import quotas have never been popular amongst consumers. They are more unpopular than ever now that these restrictive measures are seen to have failed to do what was expected of them and to have aggravated a situation which was sufficiently bad without them. Ministers of Commerce have always declared that quotas were an expedient which would be abandoned as soon as it was possible to do so without endangering home industries, but they have, nevertheless, made the fullest use of them, and have generalised a practice from which it is now difficult to escape. Coal consumers complain particularly of being unable to rely upon supplies of English and Welsh coal, which is selling in this country at the same price as the French, and is of a superior quality. At a time when manufacturing costs must be reduced, this restriction of supplies of a quality of coal which is an essential factor in manufacturing economy is contrary to the general principle that raw material should be freely admitted. The way in which quotas are being manipulated has aroused considerable distrust in them, and there are indications that their method of application will be modified to fit in with a general plan that takes into account the interests of all concerned, and not of particular interests, as is the case at present. They will not be abandoned so long as international competition in coal is carried on by means of subsidies. Some consignments of Polish coal have been made to La Pallice and other Atlantic ports. A cargo is said to be on its way from Gdynia to Dakar in Senegal.

Blast-furnace Gases.

Iron and steel firms are so entirely dependent upon blast-furnace gases for electrical production that the damping down of furnaces is a serious matter. The output of iron and steel is controlled by means of quotas for each producer, and when the quota of pig iron is reached, the damping down of a furnace may interfere with the electricity supply to the rolling mills. So complete is this dependence on the gas supply that the furnace is now regarded primarily as a gas producer, and the limitation of pig iron output has raised a problem of regularity in gas supply, the solution of which is not easy to find. The connecting up of works with the electricity supply, so that any surplus may be diverted from one to another, is not always satisfactory, and it is now proposed to provide for a distribution of gas amongst works in a particular district in a way to provide for an exchange of gas for pig iron and steel. Some acceptable formula is now being sought that will allow of the total blast-furnace gas supply being distributed to meet the requirements of rolling mills when the pig iron output in a particular works is reduced.

Foreign Trade.

The detailed figures relating to foreign trade during 1933 show that Great Britain continued to be one of the leading buyers of French products, the total value of French goods purchased being 1676 million francs, while the imports from Great Britain into France were valued at 2166 millions. The exports from France to Germany amounted to 1702 million francs, and the imports from that country totalled 3043 millions. The Belgian-Luxemburg Union purchased products from France to the value of 2140 million francs, and its sales to this country totalled 1965 millions. While taking only 868 million francs' work of French products, the United States exported goods and produce to the value of 2850 millions. Imports from and exports to the British Dominions were respectively as follows:—Australia, 672,834,000f. and 67,893,000f.; South Africa, 307,657,000f. and 45,549,000f.; Canada, 318,304,000f. and 109,844,000f.; Irish Free State, 10,140,000f. and 17,847,000f.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

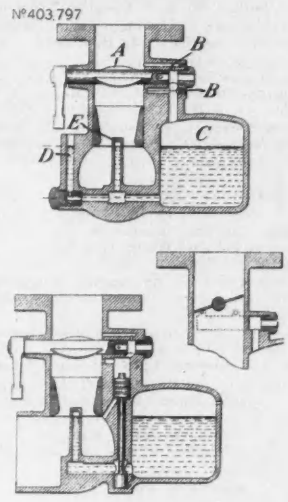
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

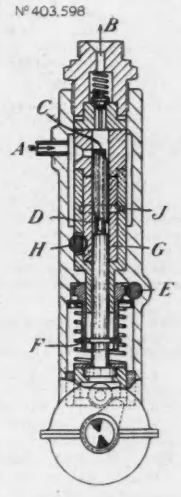
403,797. November 24th, 1932.—CARBURETTORS, Société Anonyme Solex, 190 Avenue de Neuilly, Neuilly-sur-Seine (Seine), France.

In this carburettor the butterfly throttle valve A is by-passed by the passages B B, which, in turn, are throttled by the movement of the ports in the valve spindle. A suction is thus produced above the surface of the fuel in the float chamber C. Should this suction exceed the hydrostatic pressure in the column D, the spirit will be sucked back and the consequent admission of air to the jet E will so weaken the mixture that the engine speed will be reduced to the normal.—*January 4th, 1932.*



403,598. August 14th, 1933.—FUEL INJECTION PUMPS, R. Bosch, Aktiengesellschaft, 4, Militarstrasse, Stuttgart, Germany.

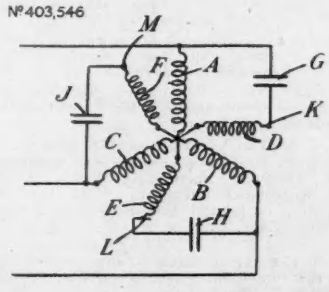
In this pump arrangements are made for controlling both the suction and the delivery. The suction is shown at A and the delivery at B. The piston has two helical faces C and D and can be rotated by the worm E through the pin F. On rotation the face C passes across the inlet port and determines the amount of oil sucked in. The sleeve G can be rotated by the worm H and has a by-pass port J which acts in conjunction with the face D to determine the extent of the delivery.—*December 28th, 1933.*



DYNAMOS AND MOTORS.

403,546. March 17th, 1932.—POLYPHASE ALTERNATING CURRENT MOTORS, The English Electric Company, Ltd., of Queen's House, 28, Kingsway, W.C.2, and Reginald Donahoe Ball, of Phœnix Works, Bradford.

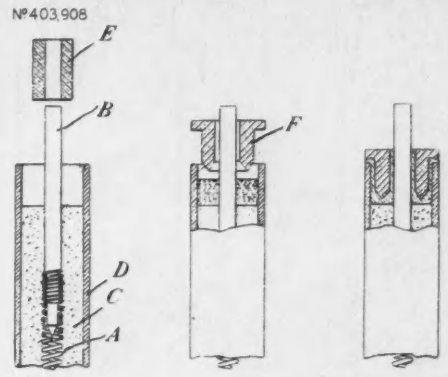
The object of this invention is to improve the power factor of polyphase motors. The main windings A, B, and C are star-connected. Auxiliary or auto-transformer windings D, E, and F are also connected to the star point, and condensers are connected at G, H, J. Each auxiliary winding, such as D, is approximately 90 deg. out of phase with respect to its corresponding main winding, such as A. The turns and phase angles of the auxiliary windings are chosen to give the required PD's across the condensers, a particularly useful arrangement being one which impresses on the condensers a PD lying between the phase voltage and the line voltage. If, during starting, the three junctions of main and auxiliary windings be disconnected temporarily from the star point and the points K, L, M be temporarily connected together, the main and auxiliary windings will be in series and the condensers will have the phase voltage applied to them. A suitable switching scheme for this arrangement, which results in a reduced starting current and torque, is described.—*December 28th, 1933.*



ELECTRICAL APPLIANCES.

403,908. August 4th, 1933.—ELECTRIC HEATER RESISTANCES, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.*

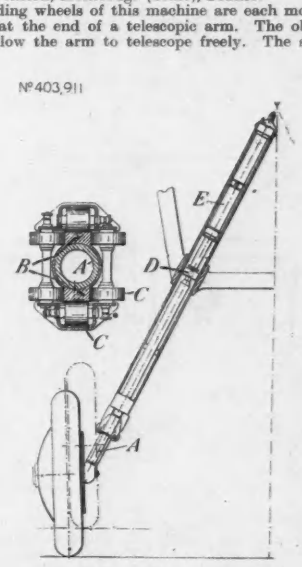
This invention is concerned with heating resistance elements in which the resistance wire is embedded in an insulating material enclosed by a metallic sheath. The idea is principally concerned with the sealing of the ends of the element to prevent the ingress of moisture. The helical wire A is screwed on to the terminal rod B, to ensure metallic contact, and is embedded in the insulator C, which may be magnesium oxide. The insulating material is surrounded by the tube D. After the filling is completed, the tube is swaged to reduce its diameter and compact the filling. A slug of glass E is then threaded on the terminal, the element is raised, by degrees, to a temperature of about 1750 deg. Fah., and the ferrule F is forced in to close the end. It is suggested that a nickel-manganese alloy should be used for the terminal.—*January 4th, 1934.*



AERONAUTICS.

403,911. August 16th, 1933.—LANDING TRAING FOR AEROPLANES, Société Française de Matériel d'Aviation, 58 Rue Fénelon, Montrouge (Seine), France.

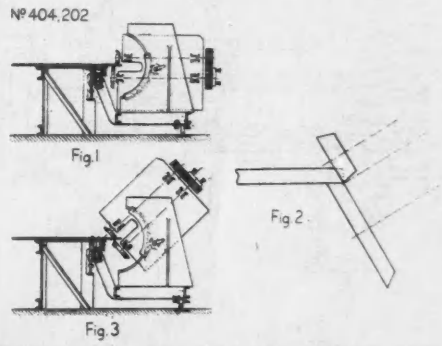
The landing wheels of this machine are each mounted on a stub axle at the end of a telescopic arm. The object aimed at is to allow the arm to telescope freely. The stub axle is extended by the shaft A, which has fins, as shown at B, B. These fins are engaged by rollers C, C, on the end of the arm, and the shaft is, consequently, prevented from turning. The upper end of the shaft is attached at D to a damper E by means of a universal joint, so that any straining of the parts does not bind them together.—*January 4th, 1934.*



MACHINE TOOLS AND SHOP APPLIANCES.

404,202. May 29th, 1933.—CIRCULAR BLADE SHEARING MACHINES, W. Schmidt, Burgstrasse 14, Erfurt, Germany.

This invention is principally concerned with the preparation of the edges of steel plates, such as those used in boiler construction, which are generally planed along the edges. The inventor suggests, in a verbose specification, that the usual process is expensive, and that an alternative use should be made of rotary shearing discs made to travel along the length of the stationary plate. The shearing discs are mounted on a head which can be slewed to give any reasonable angle of cut,



and are driven through slipping clutches, so that should one be more ground down in resharpening, than the other, slipping between the two will not occur. In order to ensure that there is no scurf on the edge of the plate the cutting rolls may be arranged as in Fig. 2.—*January 11th*, 1934.

MISCELLANEOUS.

403,529. January 12th, 1933.—ROCK DRILLS, Aktiebolaget Atlas Diesel, Sicla, Stockholm, Sweden.

The object of this invention is to provide a rock drill which is "more resistive," from which term and the context, we presume, is meant a drill which will retain its cutting properties

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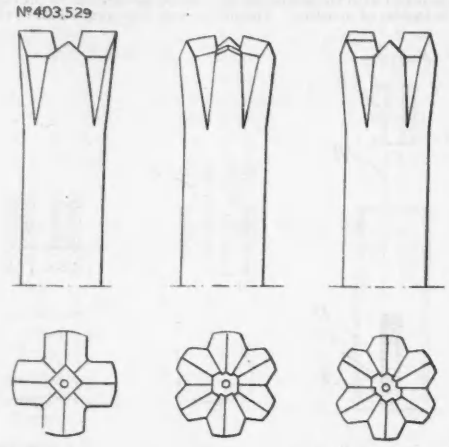

longer than the normal drill. This effect is produced by providing a series of cutting edges of varying heights, which wear down, in turn, and expose the lower ones to action. It is said in the specification that such drills have been proved to be 15 per cent. quicker in action than normal drills.—*December 28th*, 1933.

403,913. August 28th, 1933.—PULPING MACHINES FOR PAPER-MAKING, E. Schneebeli, Gieshübelstrasse 64, Zurich, Switzerland.

This pulp grinder is said to have been proved by experiment to use less power than other known grinders. It comprises two discs A and B, the upper one of which is driven by the motor C. Each of the discs is equipped with renewable teeth that

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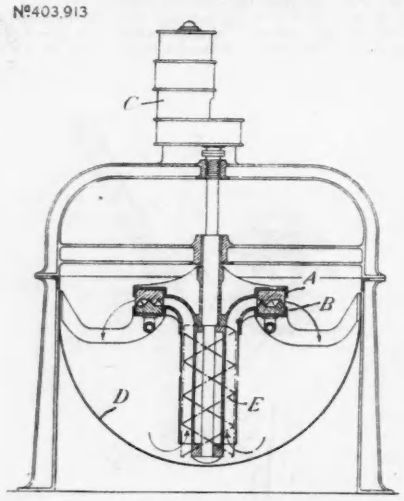

intermesh. The "stuff" is held in a pot D and is fed upwardly between the grinding discs by the worm E, to be discharged outward by centrifugal action. The grinding zone is above the water level, so that the discs are easily accessible for the renewal of the teeth. The teeth may be of metal or of basalt lava. It is claimed that the pulp is not cut up or minced by the grinding teeth, but the fibres are ground, or fibrillated, while losing little of their original strength.—*January 4th*, 1934.

403,916. September 8th, 1933.—INJECTORS, L. Friedmann and M. Friedmann, 6 am Tabor, Vienna II, Austria.

This is an exhaust steam injector, with an auxiliary supply of live steam. It is pointed out that injectors of this type usually have hinged flap nozzles to allow the steam to escape

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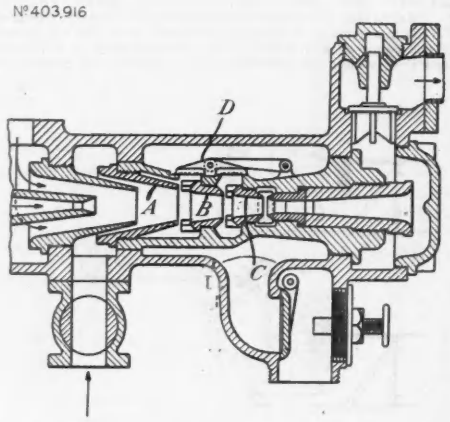

through the overflow chamber at starting; but such a construction, it is claimed, is expensive and subject to serious wear. As an alternative, the inventors propose to use a combining nozzle made up of several detached sections A, B, C, and to provide the temporary outlet for the steam by means of a clock valve D. The several parts of the nozzle are, it will be seen, easily replaceable.—*January 4th*, 1934.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF CHEMICAL ENGINEERS.—Hotel Victoria, Northumberland-avenue, W.C.2. Twelfth Annual Corporate Meeting. Presentation of Medals. Presidential Address, "Chemical Engineering and the Edible Fat Industry," 11 a.m. "Modern Methods of Attacking Heat Transmission Problems," Prof. C. H. Lander, 2.15 p.m. Twelfth annual dinner, 7 p.m., for 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: LONDON STUDENTS.—Savoy-place, W.C.2. "A Philosophy of Tariffs," Mr. R. B. Rowson. 6.15 p.m.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN STUDENTS.—Armstrong College, Newcastle-upon-Tyne. "Tapping the High-tension 'Grid,'" Mr. T. D. Oswald. 7.15 p.m.

INST. OF LOCOMOTIVE ENGINEERS.—Danum Hotel, Doncaster. "Speeding up Train Services," Mr. B. W. Selby. 6.30 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Annual general meeting. Discussion, "Some Factors in the Design of Surface Condensing Plant," Messrs. H. L. Guy and E. V. Winstanley. 5.30 p.m.

INST. OF STRUCTURAL ENGINEERS: WESTERN COUNTIES BRANCH.—At Merchant Venturers' Technical College, Bristol. "Application of the L.C.C. Code of Practice," Mr. C. H. Williams. 7.15 p.m.

INST. OF TRANSPORT.—At Connaught Rooms, Great Queen-street, W.C.2. Annual dinner. 6.30 p.m. for 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Clarification of Polluted Water with Particular Reference to Colliery Wastes and Sewage," Dr. R. D. Gifford. 7.30 p.m.

MANCHESTER ASSOC. OF ENGINEERS.—Engineers' Club, 17, Albert-square, Manchester. Annual dinner. Reception, 6.45 p.m.; dinner, 7.15 p.m.

PHYSICAL SOC.—At Imperial College of Science and Technology, S. Kensington, S.W.7. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.; meeting, 5 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, "Surface Tension," Mr. Allan Ferguson. 9 p.m.

WEST OF SCOTLAND IRON AND STEEL INST.—Royal Technical College, Glasgow. Council meeting, 6.45 p.m. "New Developments in Design of Rolling Mills Equipment," Herr Dipl. Ing. Ernst Kugel. 7.15 p.m.

SATURDAY, FEBRUARY 17TH.

INST. OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Engineers' Club, Manchester. "Production of Specially Hard Cast Irons by Alloying and Heat Treatment," Mr. W. T. Griffiths. 4 p.m.

INST. OF CIVIL ENGINEERS.—Students' Visit to Dagenham works of Samuel Williams and Sons, Ltd. Afternoon.

NORTH OF ENGLAND INST. OF MINING AND MECHANICAL ENGINEERS.—Newcastle-upon-Tyne. Discussion, "Second Progress Report of the Support of Workings in Mines Committee." Paper, "Earth Resistivity Surveys on Various Geological Structures relating to Mining," Prof. Granville Poole, Mr. J. T. Whetton, and Mr. J. A. Taylor. 2.30 p.m.

MONDAY, FEBRUARY 19TH.

BRADFORD ENGINEERING SOC.—At Technical College, Bradford. "Pulverised Fuel Firing," Mr. P. Howden. 7.30 p.m.

ENGINEERS' GERMAN CIRCLE.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Schnelltriebwagen der Deutschen Reichsbahn (Fast Rail-cars on the German State Railways)," and "Mit dem Fliegenden Hamburger von Hamburg nach Berlin (With the Flying Hamburger from Hamburg to Berlin)," illustrated with kinema films, by a Technical Expert from the Deutsche Reichsbahn Gesellschaft (German State Railways). 6 p.m.

INST. OF AUTOMOBILE ENGINEERS.—At Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow, C.2. "Aero Engine Design," Capt. G. S. Wilkinson. 7.30 p.m.

INST. OF MECHANICAL ENGINEERS: GRADUATES' SECTION.—Storey's-gate, S.W.1. "Temperature Control as Applied to General Refrigeration," Mr. F. H. Slade. 6.45 p.m.

INST. OF STRUCTURAL ENGINEERS: JUNIOR MEMBERS.—10, Upper Belgrave-street, S.W.1. "Building Practice in its Various Aspects." 6.45 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2.—Thomas Gray Lecture, "Deep Diving and Under-water Rescue," Sir Robert H. Davis. 8 p.m.

MONDAY, FEBRUARY 19TH, TO FRIDAY, MARCH 2ND.

BRITISH INDUSTRIES FAIR.—Castle Bromwich, Birmingham. Daily, 10 a.m. to 6 p.m. Olympia and White City, London, open daily.

TUESDAY, FEBRUARY 20TH.

ILLUMINATING ENGINEERING SOC.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Heterochromatic Photometry," Mr. H. Buckley. 7 p.m.

INST. OF AUTOMOBILE ENGINEERS.—Victoria Hotel, Wolverhampton. "Body Design for Public Service Vehicles," Mr. A. J. Romer. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND CENTRE.—Hotel Metropole, Leeds. "The Application of Automatic Voltage and Switch Control to Electrical Distributing Systems," Messrs. W. Kidd and J. L. Carr. 7 p.m.

INST. OF METALS: SWANSEA LOCAL SECTION.—At Y.M.C.A., Swansea. "Cracking and Fracture of Metals with Special Reference to Service Breakages," Professor F. Bacon. 6.15 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield. "Recent Developments in the Foundry Industry," Mr. V. C. Faulkner. 7.30 p.m.

WEDNESDAY, FEBRUARY 21ST.

INSTITUTIONS OF CIVIL ENGINEERS (BIRMINGHAM AND DISTRICT ASSOCN.), MECHANICAL ENGINEERS (MIDLAND BRANCH), ELECTRICAL ENGINEERS (S. MIDLAND CENTRE).—Joint meeting at Central Technical College, Suffolk-street, Birmingham. "Effective Use of Coal," Prof. R. V. Wheeler. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: LONDON STUDENTS.—Florence Restaurant, 53, Rupert-street, W.1. Twenty-seventh annual dinner, 7.15 for 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: LONDON STUDENTS.—Visit to Broadcasting House, W.1. 1.15 p.m.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN STUDENTS.—County Hotel, Newcastle-upon-Tyne. Annual dinner. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND CENTRE.—At James Watt Memorial Inst., Birmingham. "The Effective Use of Coal," Prof. R. V. Wheeler. 6 p.m.

INST. OF FUEL.—At Engineers' Club, Manchester. "Pulverised Coal," Commander H. D. Tollemache. 7 p.m.

INST. OF MECHANICAL ENGINEERS.—Grand Hotel, Sheffield. "Application of Tapered Anti-friction Bearings to Steel Mills," Mr. J. H. Boden. 7.30 p.m.

INST. OF STRUCTURAL ENGINEERS: SCOTTISH BRANCH.—129, Bath-street, Glasgow. "Water Ratio Rules and their Limitations," Mr. W. Hunter. 7.30 p.m.

NEWCOMEN SOC.—At Prince Henry's Room, 17, Fleet-street, E.C.4. Communicated paper, "Early History of Streets and Pavements in London." 5.30 p.m.

ROYAL METEOROLOGICAL SOC.—49, Cromwell-road, S. Kensington, S.W.7. Meeting at 5 p.m.

ROYAL MICROSCOPICAL SOC.—B.M.A. House, Tavistock-square, W.C.1. Meeting, 5.30 p.m.

RUGBY ENGINEERING SOC. AND INST. OF ELECTRICAL ENGINEERS, S. MIDLAND STUDENTS.—Visit to Coventry works of British Thomson-Houston Company, Ltd., 3 p.m.; joint meeting at Benn Buildings, High-street, Rugby, "Induction Voltage Regulator and its Control Gear," Mr. R. P. E. Tabb, 7 p.m.

THURSDAY, FEBRUARY 22ND.

INST. OF FUEL.—St. Ermin's Hotel, Caxton-street, S.W.1. Discussion, "Should Large Coal be Crushed to Meet the Increasing Demand for Smalls?"

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, W.C.2. "Safety Measures in X-ray Work, Including High-voltage Flexible Cables," Mr. L. G. H. Sarsfield. 5.30 p.m. for 6 p.m.

INST. OF LOCOMOTIVE ENGINEERS.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Railcars," Mr. Julian S. Tritton. 6 p.m.

INST. OF MECHANICAL ENGINEERS.—Hotel Metropole, Leeds. "Heat Liberation and Transmission in Large Steam Generating Plants," Mr. E. W. Robey and Mr. W. F. Harlow. 7.30 p.m.

INST. OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W.1. "Metallic Materials of Construction," Dr. W. Rosenhain. 6.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. "Elements of Crystal Analysis," Sir William Bragg, F.R.S. 5.15 p.m.

FRIDAY, FEBRUARY 23RD.

CHEMICAL ENGINEERING GROUP.—Joint meeting with Liverpool Section. At Muspratt Lecture Theatre, University of Liverpool. "Safety Precautions in Chemical Manufacture," Mr. J. T. Dixon, 5.30 p.m. At Liverpool Constitutional Club, India Buildings, Water-street, Liverpool. Informal dinner.

INST. OF MARINE ENGINEERS.—Grosvenor House, Park-lane, W.1. Annual dinner. 7 p.m.

INST. OF STRUCTURAL ENGINEERS: MIDLAND COUNTIES BRANCH.—James Watt Memorial Inst., Birmingham. "Application of Scale Models to Engineering Design," Mr. John Dosser. 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1.—"Some Modern Improvements in Electrical Instruments," Mr. G. F. Shotter. 7.30 p.m.

RAILWAY CLUB.—At Royal Scottish Corporation Hall, Fetter-lane, E.C.4. Annual general meeting. Presidential address, "Plymouth and Dartmoor Railway," Mr. Kenneth Brown. 7.30 p.m.

MONDAY, FEBRUARY 26TH.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND CENTRE.—At The University, Birmingham. "Applications of Automatic Voltage and Switch Control to Electrical Distribution Systems," Messrs. W. Kidd and J. L. Carr. 7 p.m.

TUESDAY, FEBRUARY 27TH.

DIESEL ENGINE USERS ASSOC.—At Pagani's Restaurant, 42/49, Great Portland-street, W.1. Annual dinner, 7 for 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—At 39, Elmbank-crescent, Glasgow, C.2. "Measurement of Noise, with Special Reference to Engineering Noise Problems," Messrs. B. A. G. Churcher, A. J. King, and H. Davies. 7.30 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Comparative Method of Estimating the Hull Weight of a Ship," Mr. G. R. Johnson. 7.30 p.m.

INST. OF STRUCTURAL ENGINEERS: LANCS. AND CHESHIRE BRANCH.—At Liverpool Engineering Soc., Liverpool. "Foundations," Mr. G. B. R. Pimm. 7 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield. "Manufacture of Sand Spun Pipes," Mr. J. B. Allan. 7.30. p.m.

WEDNESDAY, FEBRUARY 28TH.

INST. OF AUTOMOBILE ENGINEERS.—At Engineers' Club, Manchester. "Aero Engine Design," Capt. G. S. Wilkinson. 7 p.m.

INST. OF FUEL.—Visit to J. Lyons and Co., Ltd., works at Cadby Hall, Hammersmith and Greenford. Leave St. Ermin's Hotel, 10 a.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Gordon Restaurant, Gordon-street, Glasgow. Informal luncheon. 1 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "The Canning Industry," Mr. T. N. Morris. 8 p.m.

THURSDAY, MARCH 1ST.

INST. OF CIVIL ENGINEERS.—Hotel Metropole, Leeds. The Vernon Harcourt Lecture, Mr. J. A. Sauer. 7.30 p.m.

FRIDAY, MARCH 2ND.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. Discussion, opened by Dr. A. H. Davis, "The Prevention and Suppression of Engineering Noises." 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Development of Brimsdown Power Station," Mr. H. A. Skinner. 7.30 p.m.

WEDNESDAY, MARCH 7TH.

INST. OF METALS.—Trocadero Restaurant, W.1. Annual dinner-dance. 7 p.m.

STEPHENSON LOCOMOTIVE SOC.—At King's Cross Station, N.1. "A Brief Survey of Canadian Railway Systems and Transatlantic Services," Mr. A. F. Wallis. 6.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

ALFRED HERBERT, Ltd., Coventry, inform us that the address of their London Office is now 70, Vauxhall Bridge-road, S.W.1.

THE SELSON MACHINE TOOL COMPANY, Ltd., 23, Abbey House, Victoria-street, London, S.W.1, informs us that it has taken up the sole agency for "Kuhne" heading machines.

AN arrangement has been entered into between G.W.B. Electric Furnaces, Ltd. (proprietors, Gibbons Bros., Ltd., and Wild-Barfield Electric Furnaces, Ltd.), and Shell-Mex and B.P., Ltd., whereby new high-grade quenching oils will be placed on the market. These oils will be known as Shell-Wild-Barfield quenching oils, and will be obtainable from either G.W.B. Electric Furnaces, Ltd., London and Dudley, or from any of the branches of Shell-Mex and B.P., Ltd.